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**ANATOMIA FOLIAR Y MORFOLOGIA DE SEMILLAS EN ALGUNAS
ESPECIES MEXICANAS DE *AMARANTHUS***

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ABSTRACT

The foliar anatomy of eleven Mexican species of *Amaranthus* (Amaranthaceae) were reviewed. Two of the species are cultivated. The goal of the study was to produce a key to the distinguishing features. No significant differences were found between the wild species, nor the cultivated species. The general features of foliar anatomy encountered are described and sketched. A complementary morphological review of the seeds is also made.

KEY WORDS: *Amaranthus*, Amaranthaceae, foliar anatomy

RESUMEN

Se revisó la anatomía foliar de once especies mexicanas de *Amaranthus* (Amaranthaceae), dos de ellas cultivadas, con el fin de encontrar caracteres clave en la delimitación de los taxa. No se encontraron diferencias significativas entre las especies silvestres, ni entre las razas de los taxa cultivados. Se describe y esquematiza la anatomía foliar general encontrada. De manera complementaria se revisó la morfología de sus semillas.

PALABRAS CLAVE: *Amaranthus*, Amaranthaceae, anatomía foliar

INTRODUCCION

Las Amaranthaceas se distribuyen en todas las regiones tropicales y subtropicales del mundo. Desde tiempos prehistóricos, el hombre utilizó algunas de sus especies como parte de la dieta alimenticia y otras como medicinales; motivo por el cual se interesó en domesticarlas.

La familia Amaranthaceae (orden Cariophyllales) comprende cerca de 800 especies en el mundo, agrupadas en 60 géneros de plantas herbáceas, anuales muy rara vez arbustivas y perennes. Es una familia preponderantemente tropical, representada sin embargo, con algunas especies en climas templados. El número más grande de especies existe en América, un buen número las encontramos en África y solamente unas pocas especies en Asia. Las Amaranthaceas son plantas que crecen en lugares bien soleados, húmedos y con cierto grado de disturbio. Su desarrollo vegetativo es rápido y producen grandes cantidades de granos, alimento silvestre de cientos de especies de aves.

Algúnas de sus especies han evolucionado muy cerca o en forma paralela a las prácticas del hombre, esto se deduce de los hallazgos prehistóricos, donde se han encontrado granos de Amaranthaceas adventicias o asociadas a los hábitats humanos en localidades muy antiguas de la Europa mediterránea (Grubben 1975). Así se encontró como el hombre prehistórico ha apreciado los granos y hojas de las Amaranthaceas en la preparación de sus pócimas medicinales. Dentro de esta familia, son las especies de los géneros *Amaranthus* y *Celosia* las más utilizadas hasta la fecha en dietas alimenticias de grupos étnicos aislados en África y América.

Existen cerca de 20 especies del género *Amaranthus* en México creciendo en forma silvestre. Dos de ellas *Amaranthus hybridus* L. y *A. cruentus* L. fueron domesticadas por los grupos étnicos prehispánicos de México, quienes las utilizaban como parte de su dieta alimenticia y de sus rituales religiosos.

ANTECEDENTES

El género *Amaranthus* se caracteriza por tener gran variación morfológica interespecífica, sin embargo sus especies cultivadas en México *A. hybridus* y *A. cruentus*, solo presentan variación en el color y el tamaño de la panoja (inflorescencia). Tratando de encontrar características peculiares para cada raza cultivada, se llevó a cabo un análisis de las razas cultivadas en la parte Centro y Norte de México, mismas que se encuentran en el CIIDIR IPN Unidad Durango, donde el M.C. Gabriel Alejandre I. se ha dado a la tarea de colectar y preservar material genético del mayor número de razas cultivadas en México.

Los estudios anatómicos han sido de gran apoyo en la delimitación de especies, géneros, subfamilias y familias de muchísimas plantas vasculares, ejemplo de ello son las gramíneas donde este tipo de estudios proveen datos determinantes en la separación de subfamilias (Herrera-Arrieta 1994). No se conoce a la fecha un reporte de caracteres anatómicos para las especies mexicanas de este género. Por lo anterior se

llevó a cabo la presente investigación como complemento de las descripciones morfológicas del género que se llevan a cabo en el Herbario CIIDIR; con el objetivo de encontrar caracteres clave en la delimitación de las razas cultivadas.

En el análisis morfológico intraespecífico de *Amaranthus hybridus* y *A. cruentus* no se encontraron caracteres suficientes para separar o diferenciar las razas, a excepción por el color, característica variable e insuficiente para delimitar posibles variedades. Así, en la búsqueda de caracteres adicionales a los morfológicos, se llevó a cabo un estudio anatómico en láminas foliares de las razas cultivadas de *Amaranthus*. Los resultados encontrados fueron comparados con la anatomía de hojas de once especies silvestres mexicanas (Cuadro 1), que también se sometieron al estudio anatómico en la presente investigación.

Las formas de las semillas de los taxa estudiados, fueron también analizados bajo microscopio estereoscópico ($4\times$ de aumento), siguiendo el método de Alexander & Barkley (1961); cuyos resultados se reportan y esquematizan al final del presente trabajo.

MATERIALES Y METODOS

Se realizaron colectas de algunos de los taxa incluidos en este estudio, especialmente de las razas cultivadas de *Amaranthus cruentus* y *A. hybridus*.

Se analizaron los cortes de once especies silvestres mexicanas de *Amaranthus*: *A. australis* (A. Gray) Sawer, *A. caudatus* L., *A. crassipes* Schlecht., *A. cruentus*, *A. chihuahuensis* S. Wats., *A. graecizans* L., *A. greggii* S. Wats., *A. hybridus*, *A. murale* L., *A. palmeri* S. Wats., y *A. spinosus* L., de las cuales se realizaron cortes transversales de láminas foliares para estudiar su anatomía (Esau 1972). Se revizó además la epidermis, mediante la técnica de raspado utilizando hidróxido de sodio. Se revizaron cortes y epidermis a aumentos de $10\times$ (vista general), $20\times$, y $40\times$ (vista a detalle), para su descripción y esquematización.

Las semillas se revisaron en fresco bajo estereoscópico a $4\times$ de aumento.

Se revisaron también nueve razas de las especies cultivadas *Amaranthus hybridus* y *A. cruentus*, de las mismas que se tiene un Banco de Germoplasma en el CIIDIR IPN Unidad Durango.

RESULTADOS Y CONCLUSIONES

Anatomía foliar de *Amaranthus* spp.

Lámina en corte transversal generalmente amplia, muy abierta en forma de V, más de 180° , con vena media proyectada abaxialmente, solo se distingue una costilla media

principal, y lateralmente vasos secundarios, sin formar costillas. Grosor variable de 0.5 a 4 mm.

Epidermis adaxial unicelular con estomas rodeados de 3 a 5 células epidérmicas de forma irregular.

Epidermis abaxial unicelular con estomas rodeados de 4 células epidérmicas de forma penta y hexagonal.

Nervadura principal rodeada de parénquima interrumpido adaxialmente por un tabique de esclerénquima seguida del haz vascular primario formado por una capa de floema interno y externo, y en su porción media por xilema y varios vasos metaxilemáticos.

Haces vasculares secundarios laterales, circulares, rodeados por una vaina de células Kranz (de 5 a 20). Algunos haces vasculares se ven alargados aparentando ser dobles, esto se debe al nivel en que se haya hecho el corte, ya que las venas de las dicotiledóneas van en todos sentidos, a diferencia de las monocotiledóneas que sus venas son paralelas.

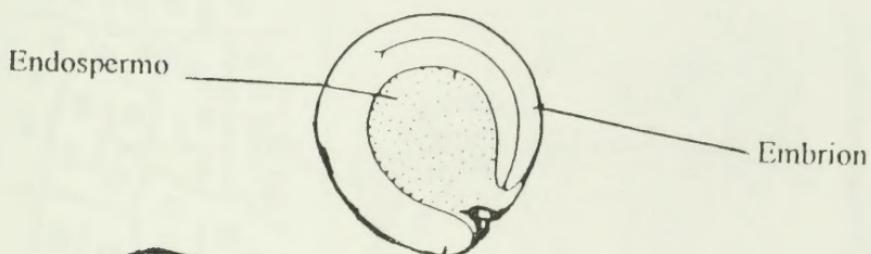
La característica distintiva del género *Amaranthus* es la presencia de una vena media vascular, la cual esta formada por un Haz vascular 1°, del doble de tamaño que los Haces vasculares 2°'s que se disponen lateralmente a todo lo largo de la hoja. Ambos Haces vasculares (1° y 2°'s) estan rodeados por celulas del tipo Kranz, lo que les confiere la característica de ser fotosintéticos tipo C₄. Dicha característica es muy importante, ya que se conoce es una adaptación de las plantas que lo portan a lugares secos o de lluvias escasas.

El corte transversal foliar presenta una costilla media abaxialmente, presenta de 5 a 10 haces vasculares 2°'s internos, laterales, los cuales varian en número según la longitud de la lámina foliar. La epidermis es uniestratificada, glabra o pubescente. Esta disposición es tipica del género, ya que no se encontró variación alguna a nivel interespecífico ni interracial.

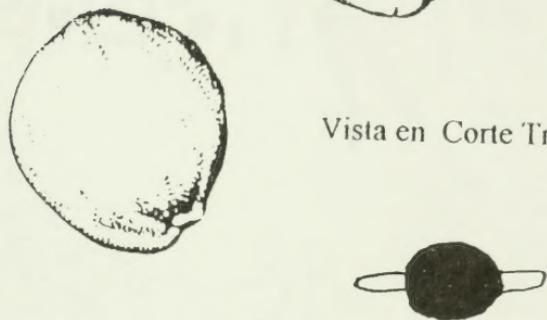
La costilla media esta formada por tejido parenquimatoso con un banda de tejido vascular estrechamente elipsoide, ligeramente curveada en posición adaxial y debajo de ella hay un tabique de esclerénquima, responsable de la escasa lignificación que caracteriza al género. La banda vascular esta formada por tres bandas: banda interna de floema, seguida de una banda de xilema con vasos metaxilemáticos y por una de floema externo.

Los Haces vasculares 2°'s (Hv 2°), estan formados por una vaina completa de células de Kranz que rodean al xilema y al floema. Existen unas macúlas adyacentes a los Hv 2°, características del género. Dependiendo del nivel de corte transversal pueden aparecer Hv 2° circulares o alargados; los alargados causan confusión ya que se semejan a dos Hv 2° circulados, fusionados, alargados, siendo un solo haz vascular 2° en unión con otro haz vascular 2°. En general *Amaranthus* presenta los Hv 2°'s dispuestos a manera de una red o interconectados unos con otros, horizontal o perpendicularmente, como puede verse en la fotografía.

Vista de Frente

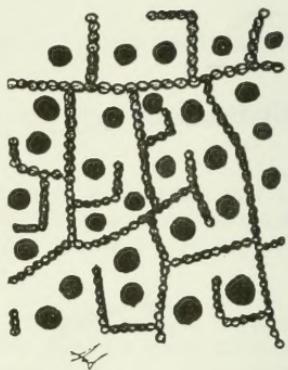


Vista en Corte Transversal

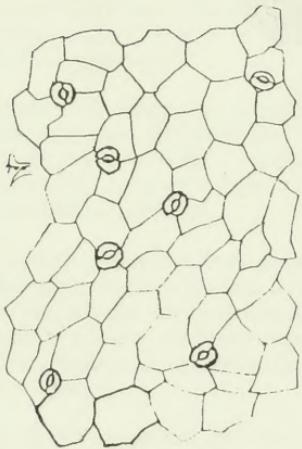




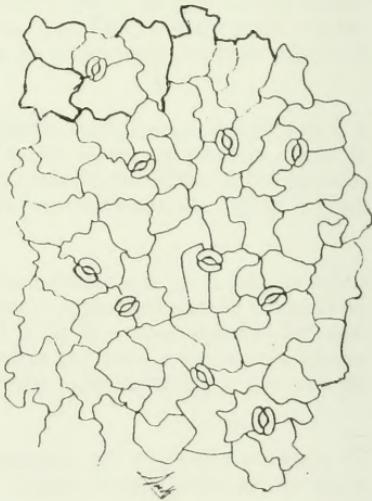
Vista superior con venación y maculas.



Planta *Amaranthus* sp.

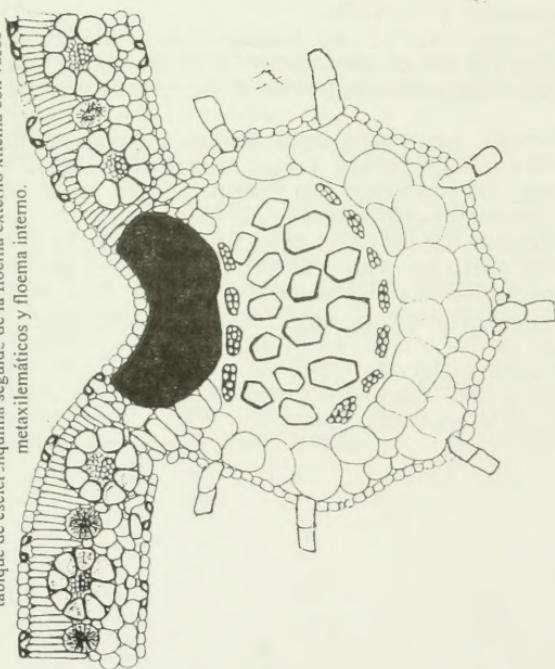


Epidermis adaxial

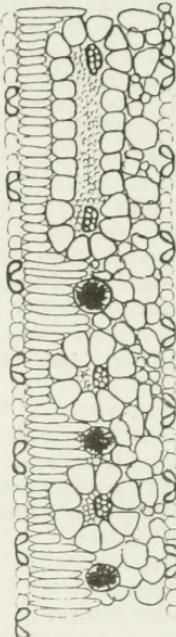


Epidermis abaxial

Vaina Media, con haces vasculares primarios rodeado de parenquima interrumpido por un tabique de esclerina que sigue a la fólema externo xilema con vasos metaxilemáticos y fólema interno.



Corte transversal de lamina *Amaranthus* sp



Haces vasculares 2° (Hv2°) de tipo Kranz: una vaina de célula Kranz que rodea al fólema y xilema. Maculas entre Hv2°.

CUADRO 1. Ejemplares incluidos en el presente estudio.

Amaranthus australis (A. Gray) Sawer. Michoacán: Orilla del Lago Cuitzeo, cerca de Coro, mpio. Zinapécuaro, 1850 m, 24 X 1985, J. Rzedowski 39227 y 39228 (CIIDIR, IEB).

Amaranthus caudatus L. Tabasco: Km 17 del Ingenio Benito Juárez hacia el C-29, sobre la línea 10 de Cárdenas, mpio. Cárdenas, 16 IV 1986, M.A. Magaña, et al. 1468 (CIIDIR).

Amaranthus crassipes Schlecht. Durango: CBTA # 3, km 7.5 carr. Durango-La Ferrería, mpio. Durango, 1900 m, 28 III 92, terreno de cultivo, S. González 5330 (CIIDIR).

Amaranthus cruentus L. México: 4 km al S de Texcoco, Montecillos, carr. México-Texcoco, 2240 m, 10 XI 83, L. Montoya 27 (CIIDIR).

Amaranthus chihuahuensis S. Wats. Durango: 8 km al SSE de Vicente Guerrero por la carretera a Súchil, 13 X 80, pastizal, S. González & Y. Herrera 1458 (CIIDIR).

Amaranthus gracizans L. Durango: 2 km al SE de 18 de Agosto, mpio. Villa Unión, 14 IX 82, matorral xerófilo, 1850 m, S. González & R. Fernández 2093 (CIIDIR).

Amaranthus greggii S. Wats. Campeche: Isla del centro de Cayo Arcos, Cd. del Carmen, 24 V 81, Zamudio 86, 87 (CIIDIR).

Amaranthus hybridus L. Durango: Km 2.5 carr. Santiago Papasquiaro-Los Altares, matorral xerófilo, 1800 m, 8 X 1990, A. Benítez 2774 (CIIDIR, MEXU); México: Zumpango, por el camino a Huehuetoca, 9 X 1981, maleza en cultivo, Y. Herrera 637 (CIIDIR).

Amaranthus murale L. Durango: Los Altares, mpio. Santiago Papasquiaro, Bosque de *Pinus arizonica*, 2430 m, 28 VII 1990, A. Benítez 1600 (CIIDIR, MEXU).

Amaranthus palmeri S. Wats. Durango: Ejido San Francisco Javier, mpio. Vicente Guerrero, 2 VII 1985, terreno de cultivo, Acevedo 220 (CIIDIR).

Amaranthus spinosus L. Chiapas: Río Pulvitallo, mpio. Yajalón, 600 m, 11 III 1983, A. Méndez 5653 (CIIDIR); Hidalgo: Carr. Pachuca-Huajolote, 3.5 km al N de Ixtlahuaco, mpio. Lolatla, 5 VI 1986, J. Arellano 448 (CIIDIR).

En las epidermis adaxial y abaxial se presentan estomas anomocíticos y tricosas multiestratificados, que se localizan sobre las venas y la cresta media.

Todas estas características fueron encontradas sin variación aparente a nivel interespecífico, como se mencionó antes, lo que nos permite concluir que la anatomía del género *Amaranthus* de México es constante en los taxa (especies y razas) que lo conforman.

Semillas de *Amaranthus* spp.

Sin variación de forma circular ampliamente obovada, de 1 a 4 mm de diámetro, con embrión externo en forma de herradura que rodea al endospermo circular. En corte transversal los lados aplanados y la porción central proyectada de manera elíptica. Color comúnmente café oscuro o dependiendo de las razas cultivadas pueden ser color crema, rojo, rosa, amarillo y café oscuro.

AGRADECIMIENTOS

Se agradece el apoyo económico para realizar el presente estudio al IPN. A la curadora del herbario CIIDIR, por las facilidades para consultar los ejemplares y a los revisores-editores de *Phytologia*.

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Herrera-Arrieta, Y. 1994. Perspectiva Histórica de la Clasificación de la familia Poaceae. *Phytologia* 76(6):433-446.

VEGETATION AND HABITAT ON A CARIBBEAN ISLAND, THE FRIAR'S BAY
SALT POND AND ADJOINING HABITATS ON THE SOUTHEAST PENINSULA
OF ST. KITTS

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ABSTRACT

Vegetative communities of the Friar's Bay area of St. Kitts are described. In addition, effects on the vegetation of recent storm events are recorded.

KEY WORDS: floristics, ecology, St. Kitts, West Indies

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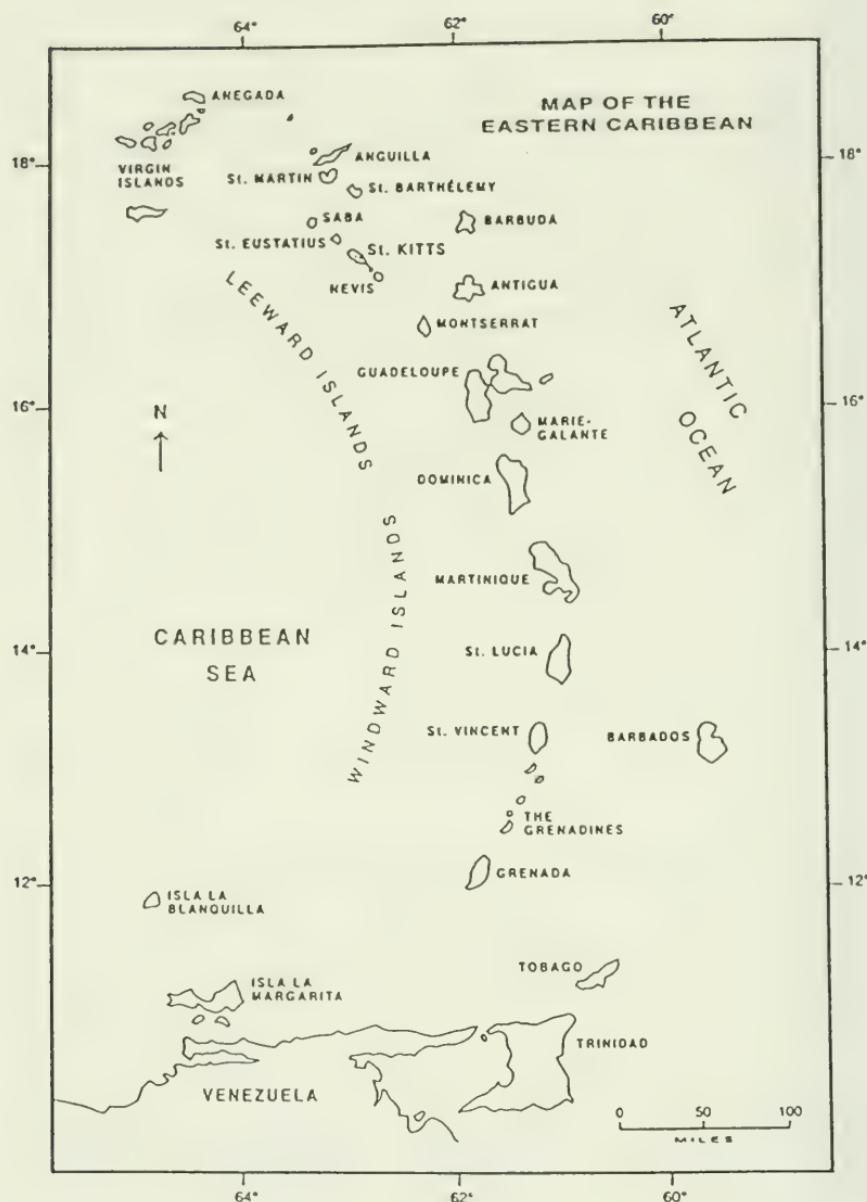
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INTRODUCTION

St. Kitts, belonging to the two-island nation of Saint Christopher & Nevis, independent of British governance since 1983, is a "lush, green" tropical island, "set in a quiet sea, and favored by an easy climate . . . , a place of rare beauty" (Merrill 1958). Situated in lat. $17^{\circ} 20'$ N and long. $62^{\circ} 45'$ W, 45 mi. west of Antigua, St. Kitts has a total area of 68 sq. mi., measuring 19 mi. (NW to SE) by 5.5 mi. (NE to SW), and is divisible into two parts: (1) the principal body of the island - from which arise the highest peaks, and where along the lowland apron and perimeter of the island sugar cane is the main crop - is rectangular in shape, about three times as long as it is broad; (2) the "southern promontory" (Box & Alston 1937), now regularly called the Southeast Peninsula, is a narrow elongation of the main body, broadening at the base which faces its sister island, Nevis, across a channel (The Narrows) two miles wide. Six miles to the north of St. Kitts lies the Dutch island of St. Eustatius ("Statia").

St. Kitts is part of the Lesser Antilles, a chain of volcanic islands composed of two segments. The northern segment, called the Leeward Islands, to which St. Kitts belongs, begins at and extends north from lat. 15° , and from, and including, Dominica, to and including Sombrero and Anguilla. The southern segment of the Lesser Antilles, called the Windward Islands, extends from and includes Martinique, south to Grenada, at lat. 12° . Barbados, Trinidad, and Tobago are not considered part of the Windward Islands (See Map 1.) It was on his second voyage of discovery in 1493 that Columbus sailed before the trade winds in a square-rigger, having the discovery of the Lesser Antilles as one of his objectives. Edmund Gosse (1925), writing ca. 1857 of his childhood, mentions how he was "now greatly taken with the geography of the West Indies There was something powerfully attractive to my fancy in the great chain of the Antilles, lying on the sea like an open bracelet, with its big jewels and little jewels strung on an invisible thread".

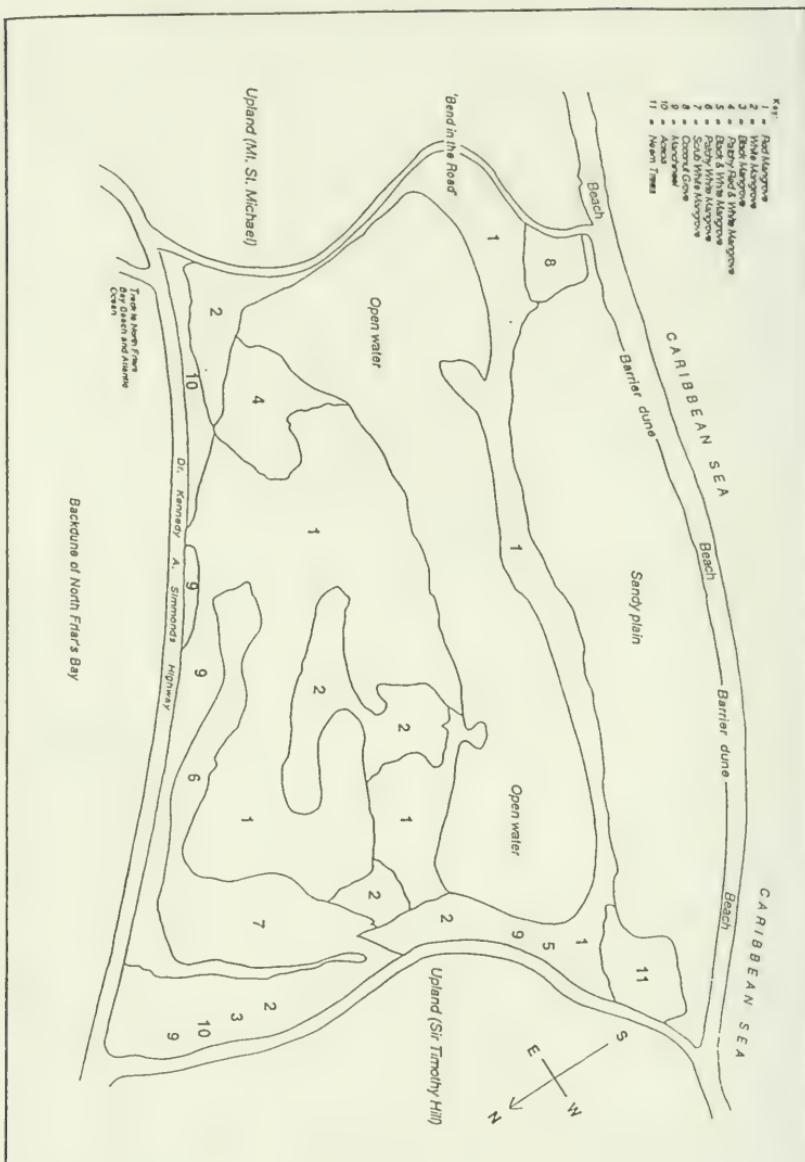
The richest association of habitats, and so the most promising site for the greatest diversity of vascular plant life, is at Friar's Bay on the Southeast Peninsula. The St. Christopher Heritage Society has already sponsored a study (Honeybrink & Daniel 1993) of the biodiversity at Friar's Bay. The Southeast Peninsula is commonly taken to refer to all the land bordering the new Dr. Kennedy A. Simmonds Highway, which begins its journey at the base of Sir Timothy Hill in Frigate Bay and ends by the side of Major's Bay facing The Narrows (see Map 5 [pages 300 and 301]). But from the point of view of the geomorphologist and geographer, the Southeast Peninsula includes the Conaree and Morne Hills, and Frigate Bay, as well as all nine salt ponds of the island (Merrill 1958) (see Map 2). As a distinctive physiographic unit, the Southeast Peninsula is characterized by scalloped and deeply indented bays, such as Half Moon Bay and North Frigate Bay, wide white sandy beaches, high dunes, as at North Friar's Bay and Sand Bank Bay, salt ponds, precipitate headlands, and a string of low worn old volcanic hills. "Friar's Bay" in general usage refers to the bays and beaches of North Friar's Bay and South Friar's Bay, and the intervening spaces, including the salt pond and its edges; more narrowly, "Friar's Bay" refers to the beach at South Friar's Bay, frequented by natives and tourists alike.



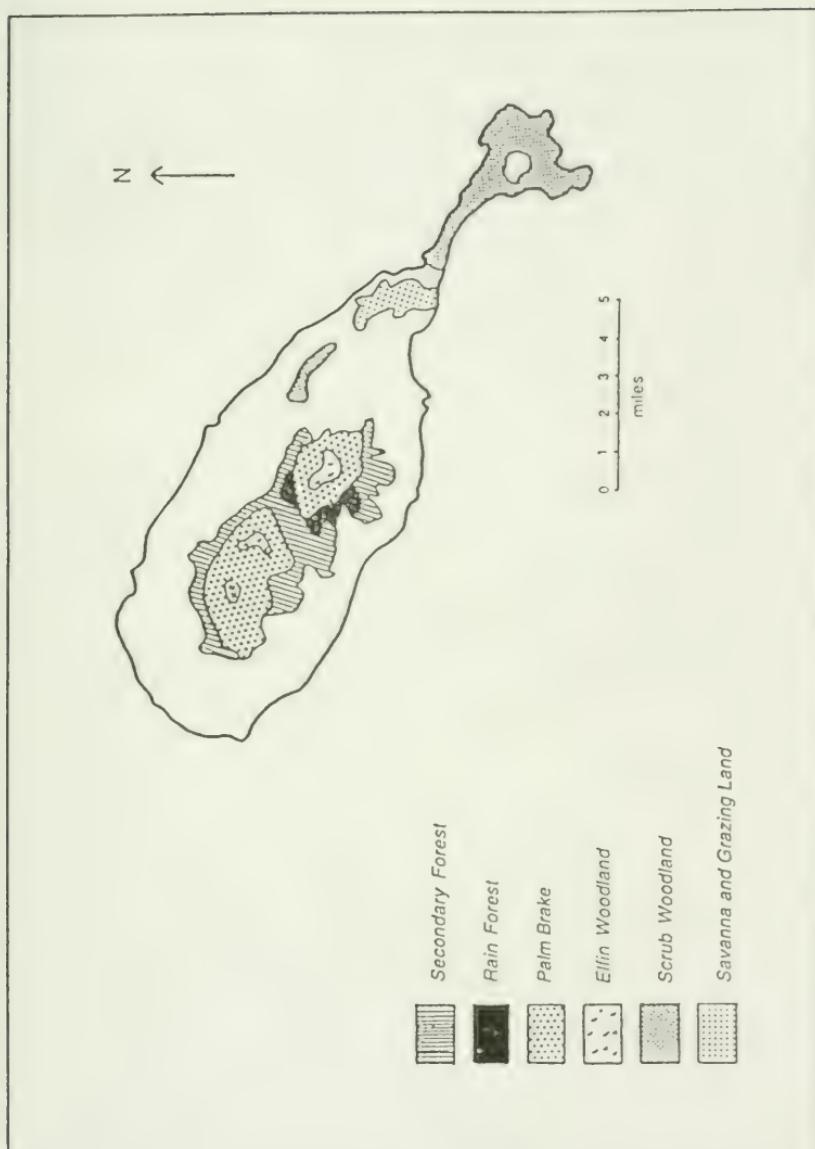
Map 1: The Eastern Caribbean, showing the position of the island of St. Kitts.



Map 2: The salt ponds of St. Kitts.



Map 3: Friar's Bay Salt Pond and its adjoining habitats.



Map 4: Vegetation map of St. Kitts by Merrill (1958), as adopted from Beard (1946).

AIMS AND METHODS

Aims

This study was undertaken to document the two principal components of biodiversity, species diversity and habitat diversity, at Friar's Bay, including its beaches, rocky shores, dunes, wetlands, and rocky hills. For greater precision in reference, Friar's Bay habitats are subdivided as follows:

- (1) beaches
 - (a) the beach at North Friar's Bay
 - (b) the beach at South Friar's Bay
- (2) rocky headlands
 - (a) at North Friar's Bay
 - (b) at South Friar's Bay
- (3) barrier dunes
 - (a) at North Friar's Bay
 - (b) at South Friar's Bay
- (4) backdunes
 - (a) at North Friar's Bay
 - (b) at South Friar's Bay
- (5) wetland (the salt pond and its mangrove woodland)
- (6) edges of the wetland
 - (a) edge of the eastern side
 - (b) edge of the western side
 - (c) edge of the southern side
- (7) uplands
 - (a) of Sir Timothy Hill
 - (b) of Mt. St. Michael
 - (c) of Turtle Bay Hill

Collections were made from the last quarter of 1994 into the first quarter of 1995. Sites (cited here using numbers from above) most often visited were (1), (2), (3), (5), (6), and (7). In total, fifteen visits were made to sites (5) and (6). Less thoroughly examined, before February 1995, than any of the habitats listed above, was (4)(a). In addition, for the sake of establishing a comparative framework for recording species diversity at Friar's Bay Salt Pond, collections were made at all of the eight other salt ponds.

Maps

The map of greatest utility for locating the salt ponds and pinpointing upland sites is D.O.S. (Directorate of Overseas Surveys, U.K.) 343, titled "St. Christopher (St. Kitts)", published in 1984, on a scale of 1:25,000. D.O.S. 343 is available from Sanford's, Long Acre Street, Covent Garden, London, England.

Plant Identifications

Dr. George R. Proctor, Department of Natural Resources, Commonwealth of Puerto Rico, identified the specimens collected. Nomenclature is based on R.A. Howard's *Flora of the Lesser Antilles*, vols. 3-6 (1978-89). Of the six volumes, Orchidaceae and Pteridophyta were not consulted.

Distribution of Collections

Collections were deposited in the herbaria of the Missouri Botanical Garden (MO) and Harvard University (GH).

MANGROVES

The essential features of the mangrove habitat are a high but variable soil salinity, and a poorly drained and often anaerobic substrate. Mangroves are represented in St. Kitts by four genera in three families:

Rhizophora mangle L. Red Mangrove
(Rhizophoraceae)

Avicennia germinans (L.) L. Black Mangrove
(Avicenniaceae)

Laguncularia racemosa (L.) Gaertn. White Mangrove
(Combretaceae)

Conocarpus erectus L. Buttonwood
(Combretaceae)

Incidence of *Conocarpus erectus*

Conocarpus erectus, possessing neither stilt roots nor pneumatophores, having no special salt secretory cells, nor exhibiting vivipary, nevertheless is a constant associate of recognized mangrove species, especially white and black, occupying in St. Kitts the more landward edges of salt pond habitats. At Friar's Bay, *Conocarpus* grows more abundantly, and in solid stands, in a habitat exposed to sea winds and salt spray; on the rocky headlands at the eastern end of North Friar's Bay, where it grows densely matted and prostrate. Moore (1906) notes that in Bermuda *Conocarpus erectus* "grows everywhere among the rocks of the seashore". *Conocarpus* is successful in other habitats: on the wooded edge of Great Salt Pond, in association with *Acacia tortuosa* (L.) Willd. and *Hippomane mancinella* L., in a site characteristic of "littoral or coastal woodland"; on the lee slope of the barrier dune between the salt pond at Half

Moon Bay and the bay's shore; as well as at an identical site at the edge of Muddy Pond.

Friar's Bay Salt Pond

Friar's Bay Salt Pond is a *Rhizophora* mangle "swamp". Occupying areas within the pond of the greatest depth of water, and creating a thicket of prop roots, *Rhizophora* "builds" the soil, ceding its own ground only when water levels change permanently. The map (Map 3) gives an impression of fixity to boundaries of "open water", but seasonal variations in the water table are extreme. Drought, over a long period, would favor increase in the population of *Laguncularia racemosa*, which now is sub-dominant at Friar's Bay Salt Pond. *Avicennia germinans* is rare at the site. If the abundance of *Avicennia* at other ponds is an indication, the species prefers wide flat moist to crusty dry salt pond margins, like those available at Great Salt Pond, but not at Friar's Bay. There is some *Conocarpus erectus* on the eastern edge of Friar's Bay Salt Pond, but there is no rank or depth of this species at that site; along that edge there are gaps where upland species have taken root, indicating a water table unfavorable to *Conocarpus*.

Ponds With Mangroves

While not all salt ponds on St. Kitts have mangrove woodlands, five of the nine do (55%). Greatheeds Pond, which is the most northerly of the island ponds, has the tallest and most dense stand of *Rhizophora* mangle. *Laguncularia racemosa*, which, in some degree, is represented at all five ponds in the set (see Table 1), is more widely distributed in St. Kitts than *Rhizophora*. *Avicennia germinans* is less often dominant than either *Rhizophora* or *Laguncularia*, but it is more often sub-dominant than either of its associates.

Table 1: DISTRIBUTION OF MANGROVES AT PONDS SURROUNDED OR NEARLY SURROUNDED BY MANGROVES ON ALL OR MOST SIDES

Pond	Dom.	Sub-Dom.	Some	None
Greatheeds	red	black	white	---
Half Moon Bay	black	---	---	---
Muddy	white	black	red	---
Friar's Bay	red	white	black	---
Cockleshell Bay	white	---	---	red & black

Ponds Without Mangroves on All Sides

Species of mangrove represented at salt ponds, being characterized primarily by the absence of mangroves on most sides, are shown in Table 2. Common features of

these ponds are: (1) *Rhizophora* is absent; (2) *Avicennia* and *Laguncularia* are equally represented; and (3) all these ponds are on the Caribbean shore or facing The Narrows. In contrast, sites of greater populations of mangrove face the Atlantic Ocean, except Friar's Bay Salt Pond, which is sited between and set back from the surrounding Atlantic Ocean and Caribbean Sea. Factors affecting composition of populations of mangrove, such as changes in water flow due to changes in tide or water table, and salinity, have not been studied.

Table 2: SPECIES AT PONDS NOT SURROUNDED BY MANGROVE

Pond	%	Most Common	Other
Frigate Bay	2	white	none
Little Salt	10	black	none
Great Salt	20	black	none
Major's Bay	15	white	black

ASSOCIATIONS OF THE OUTER PERIMETER

On all sides of the pond, the overstory is composed of tall (3.7-4.6 m) mangroves - principally red and white - growing in association with *Hippomane mancinella* and, less frequently, *Cordia obliqua* Willd. But the height and habit of the mangroves vary with the edge; overall, Friar's Bay Salt Pond is a site of shrubby mangroves more than tall trees; and the depth of the vegetation edging the pond is one rank deep on three of four sides. Indeed, in all of St. Kitts, the only site of tall tree mangroves is Greatheeds Pond. Yet it is the life and presence of Friar's Bay Salt Pond, set between scrubland hillsides, that contributes so much to the "mosaic of ecological communities" forming the "most diverse assemblages on the Southeast Peninsula" (Brown 1989).

In the story of tall shrubs and small trees, (on the western edge only) are *Acacia tortuosa*, *Avicennia germinans*, *Eugenia ligustrina* (Sw.) Willd., *Solanum racemosum*, and, less frequently, *Conocarpus erectus*. In contrast, (on the eastern edge only) are species typical of the scrub and dry forest upland adjoining the pond so closely on the eastern side, such as *Jacquinia armillaris* Jacq. (two specimens, one in the wet muds of the pond bank). *Panicum maximum* Jacq., alone of the herbaceous species, reaches a height as great as the medium-tall woody plants on the drier western edge. On the southern edge, there is no shrub layer, the confined red mangroves giving way immediately to the low herbaceous plants in the moist sand. But most frequently occurring on all sides of the pond, in the layer of shrubs of low or medium height, is *Croton astroites* Dryander, and with it, but less often, *Melochia tomentosa* L.

Herbaceous Species of the Edges

Weedy grass dominates the herbaceous story along the western edge. Other herbaceous species are occasional, such as *Chamaesyce hirta* (L.) Millsp., *Ipomoea triloba* L., *Jacquemontia cumanensis* (Kunth) Kuntze, *Mormordica charantia* L., and *Stylosanthes hamata* (L.) Taubert. *Batis maritima* L. flourishes in large patches, in association with a few shrubby *Laguncularia racemosa* on an expanse of exposed salty muds, sometimes dry and crackling, in a confined open space at the southwestern corner of the pond. On the southern margin of the pond, in ground shaded for a few hours in the morning, grow *Heliotropium curassavicum* L., *Sporobolus pyramidatus* (Lam.) Hitchc., and *Trianthema portulacastrum* L. On the eastern margin of the pond, the halophyte *Sesuvium portulacastrum* (L.) L. especially thrives in patches both in the shaded areas and in sunny openings. Less abundantly occur *Commelina diffusa* Burm., *Corchorus aestuans* L., *Heliotropium angiospermum* Murray, and *Ruellia tuberosa* L.

"Side", in the heading of the following Table 3, refers exclusively to the area between the edge of the pond and the nearest edge of any adjoining road; it excludes species that might occur on the ground edging the opposite side of the road. Sides are nearly equal in the total of their species, twelve to the west, fifteen to the east; but only three species are shared. Special to the east are the small trees more often associated with "dry forest" or upland vegetation; and common to both are a variety of "vines", which we have classified, following Howard (Howard 1978-89) ("slender", "scrambling", "woody"). *Capparis flexuosa* (L.) L., "sometimes vinelike", is also a shrub, and it has been placed in that category; but, in truth, it is both, which we note here. There are almost as many kinds of shrubs on one side as on the other, but of the species on the western (drier) side, there is a much greater abundance.

The photograph by Eric Skerritt (Figure 1 [page 299]), taken before the construction of the Dr. Kennedy A. Simmonds Highway (1987-89), shows Mt. St. Michael directly opposite the *Agave* in the foreground, and circumscribing its base, a small indentation - the roadway, now called "dirt track" - on the eastern side of Friar's Bay Salt Pond. It is along this road, on which the elements of upkeep and maintenance of the roadway have been happily neglected, that plant life is favored. On the other side of the pond the road is paved, passage to and fro the popular beach at South Friar's Bay is frequent, and the verge is from time to time enlarged by bulldozing the vegetation, thereby pushing it further into the ringing edge of mangrove trees and shrubs.

THE BEND IN THE ROAD

The dirt track along the eastern side of the pond leads from the highway to the southeastern corner of the pond, where it bends to the right and moves along to a coconut grove. The number of trees making up this grove is now much reduced. But the "bend in the road" is specially interesting, for it is a site protected from wind, where woody species from the adjoining upland of Mt. St. Michael find habitat in dry

Table 3: VEGETATION OF THE TWO SIDES OF THE SALT POND

	East Side	West Side
Overstory Trees		
<i>Cordia obliqua</i> Willd.		x
Small Trees		
<i>Bourreria succulenta</i> Jacq.	x	
<i>Capparis flexuosa</i> (L.) L.	x	
<i>Jacquinia armillaris</i> Jacq.	x	
Shrubs		
<i>Abutilon umbellatum</i> (L.) Sweet		x
<i>Chamaecrista glandulosa</i> var. <i>swartzii</i> (Wikström) Irwin & Barneby		x
<i>Clerodendron aculeatum</i> (L.) Schlecht.	x	x
<i>Cordia globosa</i> (Jacq.) Knuth	x	
<i>Lantana involucrata</i> L.	x	
<i>Rauvolfia viridis</i> Willd.	x	
<i>Sesbania sericea</i> (Willd.) Link		x
Climbing Shrubs		
<i>Tournefortia volubilis</i> L.		x
Herbs		
<i>Chamaesyce hirta</i> (L.) Millsp.		x
<i>Chloris inflata</i> Link	x	x
<i>Commelina diffusa</i> Burm.	x	
<i>Corchorus aestuans</i> L.	x	
<i>Crotalaria retusa</i> L.		x
<i>Heliotropium angiospermum</i> Murray	x	
<i>Mormordica charantia</i> L.		x
<i>Ruellia tuberosa</i> L.	x	
<i>Stylosanthes hamata</i> (L.) Taubert		x
<i>Trianthema portulacastrum</i> L.	x	
Vines		
Herbaceous Vine		
<i>Passiflora foetida</i> var. <i>hispida</i> (Triana & Planchon) Killip	x	
Slender Vines		
<i>Ipomoea triloba</i> L.		x
<i>Jacquemontia pentantha</i> (Jacq.) Don	x	x
Scrambling Shrub or Vine		
<i>Caesalpinia bonduc</i> (L.) Roxb.		x
Woody Vine		
<i>Jacquemontia cumanensis</i> (Kunth) Kuntze	x	

sand, and where a few species, typical of the interdunal sandy area nearby, find habitat as well. A similar habitat, although more extensive in area, and with *Bursera simaruba* (L.) Sarg. as tall as 12 m, adjoins Major's Bay Pond on its southeastern side. Compared to other places around the edge of the pond, there at the bend in the road are found a deeper leaf litter, and the holes of Great Land Crabs (*Cardisoma guanhumi*).

The tallest trees in the bend in the road are *Bursera simaruba*. Associated with *Bursera* is *Chamaesyce articulata* (Aubl.) Britton, some specimens appearing as small trees and others as tall shrubs. Similarly characteristic of Southeast Peninsula "dry forest" sites, and also represented at the "bend of the road", are *Capparis cynophallophora* L. and *Jacquinia armillaris*.

Other species of the woody vegetation of the site are: *Acacia tortuosa*, *Azadirachta indica* (L.) Sweet, *Clerodendron aculeatum*, *Conocarpus erectus*, *Cordia globosa*, *Croton astroites*, *Hippomane mancinella*, *Jatropha gossypifolia* L., *Lantana camara* L., *L. involucrata*, *Melochia tomentosa*, *Rauvolfia viridis*, and *Tecoma stans* (L.) Juss.

UPLAND SITES AND THEIR WOODY PLANT ASSOCIATIONS

Introduction

More imposing in the landscape of the Southeast Peninsula and more conspicuous than the salt pond at Friar's Bay are two volcanic hills descending to its edges, Mt. St. Michael from 122 m on the eastern side, and Sir Timothy Hill from 168 m on the western side. The greatest influence, in the second half of the 20th century, in defining the characteristic formations of the vascular plant life of St. Kitts generally, and of these hills and their fellows on the Southeast Peninsula in particular, has been exercised by J.S. Beard (1949). In *The Natural Vegetation of the Windward and Leeward Islands*, he lists the principal plant communities of St. Kitts as secondary forest, rain forest, palm brake, elfin woodland, scrub woodland, and savanna. Merrill (1958) adopted Beard's classification and published in his book an adaptation of Beard's map (see Map 4).

On Beard's map, all the vegetation of the Southeast Peninsula, including Sir Timothy Hill and Mt. St. Michael, is "dry scrub woodland", or Merrill's "scrub woodland". The topographic map D.O.S. 343 follows suit, but further abbreviating "dry scrub woodlands" to "scrub". As we shall see, there is greater variety in the woodland formation than "scrub" suggests. A more accurate view of the vegetation of the Southeast Peninsula, based on aerial photographs, was published by Brown (1989) in a study prepared for the Southeast Peninsula Board and the government of Saint Christopher & Nevis. He shows "grass/*Acacia*" dominating the lee slopes from Frigate Bay to Nag's Head, "thorn scrub" covering the hills facing the Atlantic Ocean, and, rarest of all the plant communities, "dry forest" occurring in ghuts on the pond-facing slope of Sir Timothy Hill as well as on the western slope of St. Anthony's Peak (see Map 5). According to Webster's *New International Dictionary of the English Language* (1935) a "ghut" (or "ghaut") is "a miniature valley or gorge excavated by running water, but through which water commonly runs after rains."

Overview of the Upland Sites

Mt. St. Michael has a nearly perfect conical form, and a complete cover of vegetation uniform in formation. Sir Timothy Hill, on the other hand, is disturbed, displaying a tumble of lower hills in no recognizable form, and a landscape of grass and *Acacia*, in addition to a slope of windswept scrub, and a għut with "dry forest" species. Across the Dr. Kennedy A. Simmonds Highway, which has cut a deep gash through the body of Sir Timothy Hill, is a lower, more seaward, outlier of the parent hill, rising to 107 m, facing North Frigate Bay on the leeside, and North Friar's Bay to the east. Within the Friar's Bay complex, this hill offers a contrast in upland vegetation different in several components from Mt. St. Michael. Finally, a hill overlooking Turtle Bay, south of Mt. St. Michael, and outside the immediate vicinity of Friar's Bay Salt Pond, was visited to gather data in support of the definition of "windswept scrub".

Species West of the Pond

Windswept Scrub Vegetation

On this hill, woody plant life is low, prostrate, windswept, and stunted. Beard (1949) says of this formation that it consists of "a dense, matted, and interlaced woody growth of gnarled shrubs usually of distorted form." A few *Jacquinia* reach 1.8 m high, but *Bursera simaruba* and *Plumeria alba* L. are absent from the site. If *Spermacoce bahamensis* (Britton) Howard is included, 66% of the species are shrubs. Woody vines, *Galactia dubia* DC. and *Stigmaphyllon adenodon* Adr. Juss., tangle the feet, and cover more of the rocky surfaces than any other plants. While only 25% of the species have thorns, prickles, or spines, the occasional presence of *Melocactus intortus* (Miller) Urban emphasizes the more xeric character of the site. *Agave caribaeicola* Trel., shown in Figure 2 (page 302), grows on this slope, as well as on all the other upland sites.

Species List of the Windswept Scrub Vegetation

Tree: *Coccoloba swartzii* Meissner in DC. (stunted). Small trees/shrubs: *Coccoloba diversifolia* Jacq. (many, but half the height of the same species on Mt. St. Michael and the crest of Sir Timothy Hill), *C. uvifera* (L.) L. (not common), *Eriothalis fruticosa* L. (abundant), and *Randia aculeata* L. Shrub: *Croton astroites*. Low shrub: *Spermacoce bahamensis*. Cactus: *Melocactus intortus* (none on Mt. St. Michael, but present and increasingly numerous, and larger, on Sir Timothy Hill seaward). Woody climber: *Urechites lutea* (L.) Britton & Rose. Woody vine: *Stigmaphyllon diversifolium* (Kunth) Adr. Juss. (common). Vine: *Galactia dubia*. Herb: *Agave caribaeicola* (occasional).

Windswept Scrub Vegetation South of Friar's Bay

The steep rocky slope above Turtle Bay faces the Atlantic Ocean, is a continuation on its southeastern side of Mt. St. Michael, and, although not immediately adjoining Friar's Bay Salt Pond, is a more typical, less disturbed, and richer site of windswept scrub vegetation. In addition, the site provides further evidence that "thorn scrub",

which is the vegetation of the site, is "scrub" but not "thorn". Only *Acacia tortuosa* and *Randia aculeata* are in some degree "thorny": *Acacia* is rare on the hill, *Randia* is occasional. The slope is steeper and closer to the sea than the site on Sir Timothy Hill, and so more affected by salt-spray and wind-blast. While vegetation (cover) is sparse, the site is richer in species than the more protected site of Sir Timothy Hill. At both sites, and on windswept hills generally, no one species is dominant. Prostrate forms, including shrubby ones, provide more cover than grasses or erect trees; and grass is not abundant, except as the habitat changes to savanna on reaching the crest of the hill. Trees of any kind are infrequent, and the tallest (*Jacquinia armillaris*), reached 3.3 m; 69% of the woody plant species are shrubs. (See Table 4.)

Table 4: COMPARATIVE DATA FROM A SECOND "THORN SCRUB" SITE: THE HILL OVERLOOKING TURTLE BAY.

Species	1	2	3	4	5	6
<i>Acacia tortuosa</i>	s	L	1.0 m	Y	N	N
<i>Capparis flexuosa</i>	s	M	-	N	Y	Y
<i>Chamaecrista glandulosa</i> var. <i>swartzii</i>	s	L	0.3 cm	N	N	N
<i>Coccocloa diversifolia</i>	s/st	M	-	N	Y	N
<i>Croton astroites</i>	s	M	0.6 cm	N	N	N
<i>Erithalis fruticosa</i>	s	M	-	N	Y	Y
<i>Jacquinia armillaris</i>	t	T	1.5 m	N	Y	Y
<i>Krameria ixine</i> L.	s	L	0.3 cm	N	N	N
<i>Pedilanthus tithymaloides</i> (L.) Poit.	s	L/M	-	N	N	Y
<i>Randia aculeata</i>	s	M	0.9 cm	Y	N	Y
<i>Spermacoce bahamensis</i>	s	L	0.3 cm	N	N	N
<i>Tabebuia heterophylla</i> (DC.) Britton	t	M	-	N	N	Y
<i>Thespesia populnea</i> (L.) Sol.	t	T	-	N	N	Y

1 = habit: s = shrub; st = small tree; t = tree

2 = relative height: L = low; M = medium; T = tall

3 = average height in 5 specimens

4 = spiny, thorny or armed: Y = yes, N = no

5 = leaves coriaceous: Y = yes, N = no

6 = Y(es) or N(o) to question: is species common component of Southeast Peninsula dry forest sites?

The Ghut

A Dry Forest Site on Sir Timothy Hill

Characteristic of the island are V- or U-shaped deep clefts incised in hard rock and volcanic ash by the cascading tumult of seasonally heavy rains; these are the ghuts. Ghuts capture and concentrate rainfall draining from the hillsides; large boulders are moved down their course, and rich sediments are transported and deposited in them. The ghut is a shadier site than the adjoining habitat, which is grassland with *Acacia* on Sir Timothy Hill. It was this contrast that Box noted (Box & Alston 1937), observing that ghuts "form an ecotone with intermediate types of vegetation, and in some of them the separation of mesophytic from extreme xerophytic associations may be but a few hundred yards".

Ghuts are less a feature of the Southeast Peninsula than they are of the main landmass of the island. In the ghut on Sir Timothy Hill, at a site 80 m above sea level, *Bursera simaruba* reaches a height of 7.6 m, and shares the site with 23 other species of woody plants, no one of which is dominant. As in all the woodland types of the Southeast Peninsula, herbaceous plants are few in kind, and, for this reason, mention is made here of *Commelinia diffusa*, the only herbaceous plant in the ghut on Sir Timothy Hill, but also found in two other sites of the Friar's Bay area: the moist edge of the pond and the xeric side of the seaward segment of Sir Timothy Hill.

The ghut of Sir Timothy Hill is the smallest habitat type (the least area) and the most species-rich site in this study. Most of its species it shares with "dry forest" sites, typical of which are *Chamaesyce articulata*, *Gymnanthes lucida* Sw., *Piscidia carthagenensis* Jacq., and *Plumeria alba*. Other species are characteristic of the open grassland with *Acacia* habitat and of disturbed edges of other formations, such as *Clerodendron aculeatum* and *Solanum racemosum*. Finally, all the large trees of the site (*Bursera*, *Hippomane*, and *Thespesia*) are the principal associates of the coastal woodland formation of the Southeast Peninsula.

Species List of the Ghut on Sir Timothy Hill

Trees: *Bursera simaruba*, *Cordia obliqua* ("arborescent shrub"), *Hippomane mancinella*, *Piscidia carthagenensis*, *Plumeria alba*, and *Thespesia populnea*. Small trees: *Bourreria succulenta*, *Capparis cynophallophora*, *Chamaesyce articulata*, *Erithalis fruticosa*, *Gymnanthes lucida*, and *Randia aculeata*. Shrubs (tall and medium): *Capparis flexuosa* (vinelike), *Citharexylum spinosum* L., *Clerodendron aculeatum*, *Coccoloba diversifolia*, *Croton astroites*, *Erythroxylum havanense* Jacq., *Eugenia ligustrina*, *Rauvolfia viridis*, and *Solanum racemosum*. Low shrub: *Pedilanthus tithymaloides*. Vine: *Pisonia aculeata* L. Herbs: *Agave caribaeicola* and *Commelinia diffusa*.

Mt. St. Michael

We examined Mt. St. Michael on its western slope, which is protected, in much greater degree than on the northeastern slope, from sea-blast in severe tropical storm, and from the ordinary harrowing winds and salt spray common throughout 7-8 months of the year. The slopes are dry and rocky. The cover of viny vegetation (*Galactia dubia* and *Stigmaphyllon diversifolium*) and the closeness of the low shrubs are such that the soil as well as the rocks are concealed from view, unlike the seaward

side of the hill, where vegetation is more sparse, and there are abundant spaces between the low shrubs. While neither of the two upland sides of the salt pond are composed of vegetation predominantly thorny, *Acacia tortuosa* is common all along the disturbed portions of the edges of both uplands where they abut a roadway. A spiny component of the hill on the western side, absent on Mt. St. Michael, is *Melocactus intortus*. *Agave caribaeicola*, on the other hand, is common to both hillsides. As to rarity, this is the only site at which *Cassine xylocarpa* Vent. was found.

Species List of Mt. St. Michael

Trees: *Bursera simaruba*, *Jacquinia armillaris*, *Plumeria alba*. Small trees: *Acacia tortuosa*, *Bourreria succulenta*, *Capparis cynophallophora*, *Coccoloba diversifolia*, *Randia aculeata*, and *Tabebuia heterophylla* (a very small tree in this site, but a huge tree by the side of Greatheeds Salt Pond). Shrubs: *Capparis flexuosa*, *Cassine xylocarpa*, *Chamaecrista obcordata* (Wikström) Britton, *Clerodendron aculeatum*, *Croton astroites*, *Erihalis fruticosa*, *Jatropha gossypifolia*, *Lantana involucrata*, *Melochia tomentosa*, *Spermacoce bahamensis*, and *Wedelia calycina* Rich. Vines: *Galactia dubia* and *Stigmaphyllon diversifolium*. Woody herb: *Stachytarpheta jamaicensis* (L.) Vahl. Suffrutescent herb: *Spermacoce verticillata*.

The Two Seaward Sides of Sir Timothy Hill

The Ordnance Survey map, D.O.S. 343, symbolizes the vegetation of St. Kitts in three types: forest, scrub and woodland, and palms. In that schema, which is simpler than Beard's or Brown's, the two seaward sides of Sir Timothy Hill are shown as "scrub & woodland". However, on examination of the species composition of the two sides, the following distinction can be made: (1) the east-facing side is a "cactus-scrub zone", with some species from "dry tropical forest"; (2) the leeside has a representative stand of "dry forest".

Collections for Table 5, in which the two seaward sides of Sir Timothy Hill are compared, have been made from areas at the top of each of the hills. On the leeside, collections were made farther down the slope than on the windward side. In addition, a few herbaceous species were collected on the edges of the parking lot. The windward side faces the rising sun, and has a vegetation more xeric than any site in the Southeast Peninsula (than any site on the island). Low shrubs, like *Coccoloba diversifolia*, are half the height of the same species on the leeside of the hill; and *Erihalis fruticosa* is smaller here than in any of its other sites (Mt. St. Michael, the għut on Sir Timothy Hill). *Acacia tortuosa* is sprawling and low, like *Chamaecrista glandulosa* var. *swartzii*, with which it is associated.

Conspicuous in contrast with the low shrubby and prostrate character of some of the vegetation is the columnar cactus, *Pilosocereus royeni* (L.) Byles & G. Rowley (stems 1.8-7.9 m tall, Howard 1989), which grows along the crest of the hill for the whole length of the trail, and down the windward slope nearly to the edge of the headlands. In St. Kitts, *Pilosocereus* is not solely an "upland" species. It grows on the flat sandy backdune adjoining the seaward side of Muddy Pond, and on the southwest side of the pond, up an overgrazed steep grassy slope, as well as less

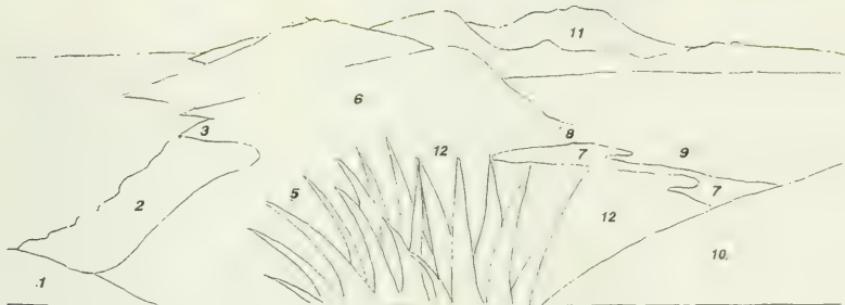


Photo 1: The photograph above was taken by Eric Skerrit 25 years before the opening of the Dr Kennedy A. Simmonds highway. The diagram below it is a key to the sites of study at Friar's Bay. The viewer stands a little back from the *Agave* on the pinnacle of the gap between Sir Timothy Hill to the right and its seaward extension to the left. The beach at North Friar's Bay is as bright and broad today as it was then.

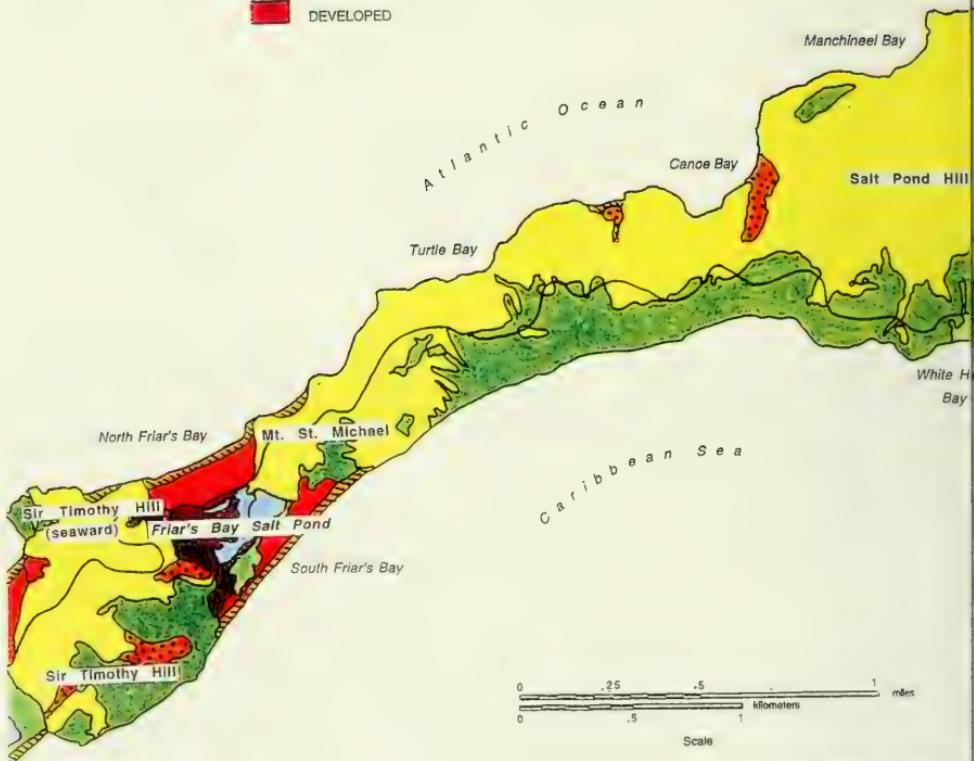
Key to the diagram: 1. Seaward Sir Timothy Hill, the xeric slope 2. Beach of North Friar's Bay 3. Rocky headland 4. Barrier-dune of North Friar's Bay 5. Thicket behind the barrier-dune at North Friar's Bay 6. Mt. St. Michael 7. Friar's Bay salt pond 8. 'Bend in the road' 9. Sandy plain 10. Windswept vegetation of the eastern slope of Sir Timothy Hill 11. Mt. Nevis on the island of Nevis 12. Mangroves

SOUTHEAST ISLAND C...

Adapted from B...

KEY

- [Light Blue] SALT POND
- [Orange with diagonal lines] BEACH
- [Red] DUNE
- [Dark Maroon] MANGROVE
- [Light Green] GUINEA GRASS
- [Dark Green] GRASS/ACACIA
- [Yellow] THORN SCRUB
- [Red with dots] DRY FOREST
- [Black] AGRICULTURE
- [Dark Red] DEVELOPED



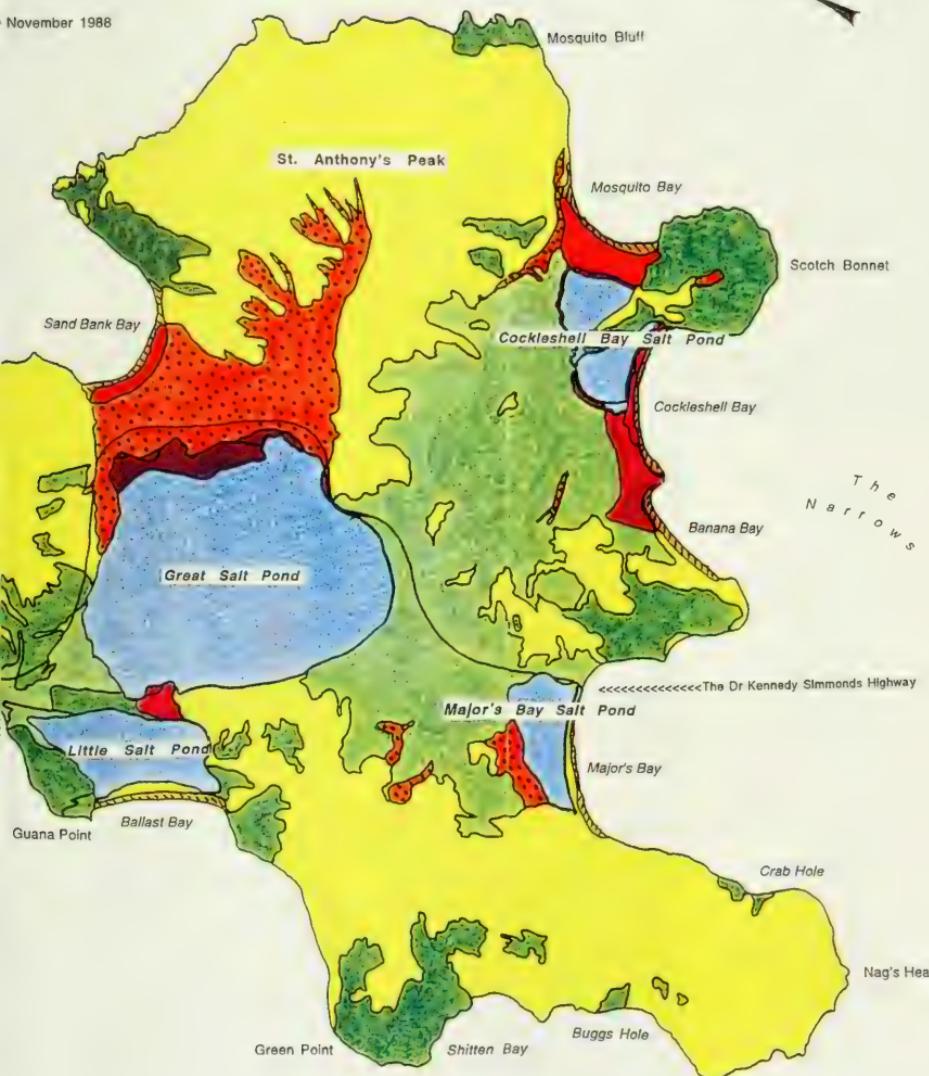
Vegetation map of the Southeast Peninsula of Barbados

M. J. ...

PENINSULA

ST. KITTS

November 1988



Map of St. Kitts, redrawn and colored, from

own.



Above: *Agave caribaeicola* (eleven specimens showing), from near the crest of the eastern slope of the seaward segment of Sir Timothy Hill, in association with *Krameria ixine*, and, in the background (left-hand corner), the cactus *Pilosocereus royeni*.

Right: *Agave caribaeicola* in bloom, with hummingbird.



abundantly on the western edge of Little Salt Pond. *Melocactus intortus* is plentiful and, in many cases, large on the windward side of seaward Sir Timothy Hill. Neither of these cacti appears on Mt. St. Michael.

On the leeside, there is a small woodland of *Bursera simaruba*, one plant reaching a height of 9.8 m, providing canopy and shade. In association with *Bursera* are *Chamaesyce articulata*, *Comocladia dodonaea* (L.) Urban, *Erythroxylum havanense*, *Eugenia ligustrina*, and *Piscidia carthagenensis*. In the shrub story, *Croton astroites* and *Wedelia calycina* are robust and abundant. Southwest on the slope, the dry forest of these species gives way to a more open hillside vegetation with *Agave caribaeicola* locally dominant. *Pedilanthus tithymaloides* is abundant in the low shrub story beneath *Bursera* and its associates.

Five Sites Compared

In the following Table 5, "A" stands for the most xeric site, at which *Melocactus intortus* and *Pilosocereus royeni* are common. From "A" to "E" there is a gradient of sparseness; "E", the "dry forest" site, is least xeric: but certainly it is not what anyone in temperate climes means by "mesic". *Pilosocereus royeni*, common in "A", but absent in "B", is nevertheless taller than most or all species in "B". "B" stands for the windswept scrub site on Sir Timothy Hill.

Table 5: FIVE UPLAND SITES NEAR FRIAR'S BAY SALT POND.

Species	A	B	C	D	E
Agavaceae					
<i>Agave caribaeicola</i> (h)	++	+	+	+	+
Amaranthaceae					
<i>Achyranthes aspera</i> L. var. <i>aspera</i> (h)	0	0	0	+	0
Anacardiaceae					
<i>Comocladia dodonaea</i> (s/st)	0	0	0	+	0
Apocynaceae					
<i>Plumeria alba</i> (st)	0	0	+	+	+
<i>Rauvolfia viridis</i> (st)	0	0	0	0	+
Asteraceae					
<i>Emilia fosbergii</i> (Nicolson) (h)	0	0	0	+	0
<i>Vernonia cinerea</i> (L.) Less. (h)	0	0	0	+	0
<i>Wedelia calycina</i> (s)	0	0	+	+	0
Bignoniaceae					
<i>Tabebuia heterophylla</i> Vahl (t)	0	0	+	+	0
Boraginaceae					
<i>Heliotropium ternatum</i> (ls)	+	0	0	0	0
Burseraceae					
<i>Bursera simaruba</i> (t)	0	0	+	+	+

Table 5 (continued):

Cactaceae					
<i>Melocactus intortus</i> (lar suc)	++	+	0	+	0
<i>Pilosocereus rojeni</i> (lar suc)	++	0	0	+	0
Capparaceae					
<i>Capparis cynophallophora</i> (st)	0	0	+	+	+
<i>Capparis flexuosa</i> (s/st)	+	0	+	0	+
Celastraceae					
<i>Gyminda latifolia</i> (Sw.) Urban (s/st)	+	0	0	0	0
Commelinaceae					
<i>Commelina diffusa</i> (h)	+	0	0	0	0
Convolvulaceae					
<i>Jacquemontia solanifolia</i> (L.) H. Hallier (wv)	0	0	0	+	0
Cyperaceae					
<i>Fimbristylis ovata</i> (Burm. f.) Kern (h)	+	0	0	0	0
Erythroxylaceae					
<i>Erythroxylum brevipes</i> DC. (s/st)	0	0	0	0	+
<i>Erythroxylum havanense</i> (s/st)	0	0	0	+	+
Euphorbiaceae					
<i>Chamaesyce articulata</i> (st)	0	0	0	+	+
<i>Croton astroites</i> (s)	+	+	+	++	+
<i>Gymnanthes lucida</i> (s/st)	0	0	0	0	+
<i>Hippomane mancinella</i> (t)	0	0	0	0	+
<i>Pedilanthus tithymaloides</i> (s)	0	0	+	+	+
Fabaceae					
<i>Acacia tortuosa</i> (s/st)	++	0	+	+	0
<i>Chamaecrista glandulosa</i> var. <i>swartzii</i> (ls)	+	0	0	0	0
<i>Galactia dubia</i> (wv)	0	+	0	+	0
<i>Piscidia carthagenensis</i> (t)	0	0	0	+	+
Krameriaceae					
<i>Krameria ixine</i> (ls)	+	0	0	0	0
Malpighiaceae					
<i>Stigmaphyllon diversifolium</i> (wv)	+	0	+	+	+
<i>Stigmaphyllon emarginatum</i> (wv)	+	0	0	0	0
Malvaceae					
<i>Sidastrum multiflorum</i> (Jacq.) Fryx. (sub)	0	0	0	+	0
<i>Thespesia populnea</i> (t)	0	0	0	+	+
Myrtaceae					
<i>Eugenia ligustrina</i> (s/st)	0	0	0	+	+
Nyctaginaceae					
<i>Pisonia aculeata</i> (wv)	0	0	0	0	+
Phytolaccaceae					
<i>Rivina humilis</i> L. (h)	0	0	0	+	0

Table 5 (continued):

Poaceae					
<i>Aristida</i> sp. (h)	+	0	0	0	0
<i>Bothriochloa pertusa</i> (L.) Camus (h)	0	0	0	+	0
<i>Heteropogon contortus</i> (L.) Beauv. <i>ex Roem. & Schult.</i> (h)	+	0	0	0	0
<i>Pappophorum pappiferum</i> (Lam.) Kuntze (h)	0	0	0	+	0
<i>Setaria setosa</i> (Sw.) Beauv. (h)	0	0	0	+	0
Polygonaceae					
<i>Coccoloba diversifolia</i> (s/st)	0	+	+	+	0
<i>Coccoloba microstachya</i> Willd. (s/st)	+	0	0	0	0
<i>Coccoloba swartzii</i> (t)	+	+	0	0	0
<i>Coccoloba uvifera</i> (t)	+	+	0	0	0
Portulacaceae					
<i>Portulaca oleracea</i> L. (h)	+	0	0	0	0
Rubiaceae					
<i>Randia aculeata</i> (st)	+	+	+	0	0
Sterculiaceae					
<i>Melochia tomentosa</i> (s)	+	0	+	0	0
Verbenaceae					
<i>Citharexylum spinosum</i> (s)	0	0	0	0	+
<i>Clerodendron aculeatum</i> (s)	0	0	+	0	0
<i>Lantana involucrata</i> (s)	0	0	+	+	0

A = Sir Timothy Hill, E-facing slope

B = Sir Timothy Hill, windswept slope

C = Mt. St. Michael

D = Sir Timothy Hill, NW slope

E = Sir Timothy Hill, ghut

0 = species not occurring at this site

+ = species occurring at this site

++ = species particularly abundant at this site

A few species, such as *Agave caribaeicola* and *Croton astroites*, are represented at all five sites, and so their presence in selectively linked sites, such as "D" plus "E", is not an indicator of habitat type. The *Agave* grows abundantly in "A", the most xeric site in the Southeast Peninsula, but also the largest specimen yet found of the *Agave* grows high on a hill adjoining St. Anthony's Peak, a "dry forest" site.

Species occurring in "D" and "E" are "dry forest" indicator species. Although *Bursera simaruba* is generally common to plentiful in dry forest sites, and characteristic of its upper story, *Bursera*, because it occurs linked to "C" as well as to "D" and "E", is not an indicator species. The same is true for *Capparis*

cynophallophora and *Plumeria alba*. On the other hand, "C" plus "D" linkages have the potentiality for indicating "scrub woodland". Especially strong dry forest indicator species are *Chamaesyce articulata*, *Erythroxylum havanense*, *Eugenia ligustrina*, and *Piscidia carthagenensis*. Two species, *Agave caribaeicola* and *Croton astroites*, are common to all five sites.

Habit of species in Table 5 is indicated in parentheses following the specific epithet. A few species are not readily classified in this way. Of the 53 plant species, twelve are herbs; the remainder, in one degree or another, are woody, including *Agave* and the two cacti. Of the twelve herbs, five are grasses. One grass species, *Heteropogon contortus*, and one (and the only) Cyperaceae, *Fimbristylis ovata*, are found together on other sites of windswept scrub vegetation in the Southeast Peninsula. These abbreviations have been used for 'habit': t = tree, s/st = shrub/small tree (sometimes appearing in each habit in one site), st = small tree, s = shrub, ls = low shrub, lar suc = large succulents, which are also woody (*Agave*, *Melocactus*, and *Pilosocereus*), wv = woody vine, sub = subshrub, and h = herb. The site is dominated by the "switch hitters" - plant species that may appear as shrubs or as small trees. There are eleven of these at seaward Sir Timothy Hill. When joined with sts (small trees), they account for 29% of the species at the site.

SANDY PLAIN

Between the southern edge of the salt pond and the lee of the barrier dune at South Friar's Bay is a flat expanse of sandy soil, which, preparatory to building a hotel on the site, was cleared of plants. The hotel has not yet been built, and the cleared land has grown over, with a tendency now toward the dominance of *Acacia tortuosa*. In the meantime, while this site, called the "Sandy Plain" in this paper, is disturbed, it is not without floral attractions. Chief of these is *Catharanthus roseus* (L.) Don, flowering persistently and growing in large stands in the western center of the area. The rich abundance throughout the plain of *Lantana camara* gives to the tropical air a sweet herbal scent. There is a sad remnant of a coconut grove (*Cocos nucifera* L.) on the far western side of the plain, and another just behind the barrier dune in the southeastern corner. In the following list, species found only on the Sandy Plain are marked with (1); species found here as well as in other sites of Friar's Bay are marked with (2).

Tree: *Cocos nucifera* (1) Small trees/shrubs: *Acacia tortuosa* (2) and *Chamaesyce articulata* (2). Shrubs: *Croton astroites* (2), *Indigofera tinctoria* L. (2), *Lantana camara* (2), and *Solanum racemosum* (2). Scrambling woody climbers: *Caesalpinia bonduc* (2) and *Urechites lutea* (2). Vines: *Canavalia roseus* (Sw.) DC. (2) and *Catharanthus roseus* (1). Suffrutescent herb: *Corchorus siliquosus* L. (1). Herbs: *Boerhavia coccinea* Miller (1), *Catharanthus roseus* (1), *Cenchrus incertus* M.A. Curtis (1), *Digitaria insularis* (L.) Mez ex Ekman (2), *Panicum maximum* (2), *Physalis philadelphica* Lam. (1), *Rhynchospermum repens* (Willd.) C.E. Hubb. (2), *Talinum fruticosum* (L.) L. Juss. ("herbaceous to slightly woody") (1), *Tephrosia cinerea* (L.) Pers. (1).

Solanum racemosum may be armed or unarmed. When armed, it has acicular spines on the midrib, veins, and stem. None of the many specimens of *Solanum racemosum* seen at Friar's Bay in 1994 and 1995, especially abundant on the sandy plain, were armed. But in January 1996 one armed specimen, with golden yellow spines, was found.

NATURALIZED SPECIES

Of nine species of vascular plants introduced and naturalized on the island of St. Kitts and found at Friar's Bay, five species, including all of the trees, are found primarily in and around the Sandy Plain, and especially where the beach of South Friar's Bay at its western extremity joins the road and the plain. Here is the grove of *Azadirachta indica* and one *Terminalia catappa* L. While the two grasses are plentiful on the plain, they are found along the dry edges of paths and roads throughout the area. The list of naturalized species includes:

TABLE 6. INTRODUCED AND NATURALIZED SPECIES OF FRIAR'S BAY.

Species	Habit	Presumed Origin	Habitat
<i>Aloe vera</i> (L.) Burm.	succulent	Mediterranean region	dry hillside
<i>Azadirachta indica</i>	tree	Indo-Malaysia	sandy plain
<i>Calotropis procera</i> (Aiton) W. Aiton	shrub	Africa	backdune
<i>Catharanthus roseus</i>	herb	Madagascar	protected sands
<i>Cocos nucifera</i>	tree	Philippine Islands and N. Australia	beaches, dunes
<i>Cordia obliqua</i>	arborescent shrub	India	pond edge
<i>Panicum maximum</i>	herb	Africa	dry open spaces
<i>Terminalia catappa</i>	tree	India	protected beach
<i>Rhynchoselytrum repens</i>	herb	Africa	dry roadsides

Of these species, *Aloe vera* is rarest and the grasses most abundant at the site.

BEACHES, DUNES, AND HEADLANDS

Compression of space between habitats at Friar's Bay, where distances are never great, enhances perception of "variety", and adds much to the pleasure of seeing "the countryside". Distance from the highest point on the seaward expression of Sir Timothy Hill to the midpoint on the edge of the pond on its western side is, in a straight line, 540 m; from one headland to another (at North Friar's Bay) it is 540 m. The beach at South Friar's Bay is longer, about 1,081 m. From the midpoint of the pond, on its eastern side, to the nearest headland of North Friar's Bay, it is 405 m.

Topographically, the beaches at the two sites are similar. Each is bounded by a rocky headland. Between the high-water mark and the barrier dune, there is a narrow sandy terrace (or berm) on which only a few species of vascular plants are rooted. At this edge, especially on the Atlantic side, where the greater danger is exposure to repeated dunkings in salt water, *Sporobolus virginicus* (L.) Kunth is alone in taking the greater risks: it colonizes spaces before the berm. On both shores, *Ipomoea pes-caprae* (L.) R.Br. is an associate of *Sporobolus*, but never ventures so far toward the sea.

Behind this area of first rootings (scattered and tentative), the same species occur in greater security of tenure, even while the sands are mobile and fugitive. Then rises the barrier dune, of no great height on the Caribbean shore, but impressive in its height and shape on the Atlantic shore. There it rises to a ridge 7 m or more. The ridge is continuous at this elevation for the entire length of the beach, and, all along its length, from base to summit, it describes a gracious curve. This curve is a bastion to the sea-mounted furies of wind, water, and spray. And every centimeter of the sands composing the material substance of this great work is held resolutely in place by *Coccoloba uvifera*. To the lee of the barrier dune, where protection from seaborne winds is afforded, species diversity is higher: these are the "thickets", characteristic of Caribbean coastal sites, and well-developed at North Friar's Bay.

Comparative Data on the Structure of Beach Vegetation

Beard (1949) uses the term "littoral woodland" to encompass a variety of vegetations including "sand-dune vegetation", "vegetation of salt flats", and "rocky slopes". The vegetation of sandy beaches, as studied at North Friar's Bay, and with supplementary observations at Sand Bank Bay, Mosquito Bay, and Half Moon Bay to Muddy Point (see Table 7), may be subdivided into eight zones: **Zone 1**: Wet sand on which seaweeds and sea grasses (*Syringodium filiforme* and *Thalassia testudinum*) are washed and are picked over by shorebirds. **Zone 2**: A scattering of *Sporobolus virginicus* pioneers. **Zone 3** (drier than Zone 2): Large patches, some continuous for a distance, of *Sporobolus virginicus*, with *Ipomoea pes-caprae* and, on the Caribbean shore of South Friar's Bay, but not at all on the north, *Canavalia rosea*. **Zone 4**: Slope of the barrier dune, the most densely vegetated site of the strand, and most often dominated by *Coccoloba uvifera*. It has a foot and a crest. Species of the foot are usually the same as those of the slope, but the crest may vary, and is treated as Zone 5. **Zone 5**: At North Friar's Bay, the crest of the seaward face of the barrier dune has the same species as the slope, but this is not always true in all dunes of the peninsula; and so it is useful to separate the two sites. **Zone 6**: The backslope of the barrier

dune is most often vegetated with species of the thicket, composing the body of the interdunal vegetation; at North Friar's Bay, the crest of the dune is a gently undulating plain, extending a great distance, and supporting a forest of *Coccoloba uvifera*. Nevertheless, the distinction is useful, as we shall see in looking at data from other beaches. **Zone 7:** Shrubs and small trees, other than *Coccoloba uvifera*, dominate the interdunal thicket. **Zone 8:** In some sites behind a beach, and well protected from wind and salt spray, a *Bursera*-dominated coastal woodland occurs; but this formation is not discussed further in this paper.

Table 7: A COMPARISON OF SPECIES FROM SOME OF THE BEACHES OF THE SOUTHEAST PENINSULA.

Species collected at Zones 4 & 5, the slope and crest of the barrier dune:

Species	A	B	C	D.
<i>Argusia gnaphalodes</i> (L.) Heine	o	+	+	o
<i>Blutaparon vermiculare</i>	+	o	o	o
<i>Caesalpinia bonduc</i>	o	o	o	+
<i>Chamaesyce mesembrianthemifolia</i> (Jacq.) Dugand	+	+	o	o
<i>Coccoloba uvifera</i>	+	+	+	+
<i>Corchorus hirsutus</i>	o	o	o	+
<i>Erihalis fruticosa</i>	o	+	+	o
<i>Scaevola plumieri</i> (L.) Vahl	+	o	o	o
<i>Sesuvium portulacastrum</i>	+	o	o	o
<i>Sporobolus virginicus</i>	+	+	+	+

Note: *Scaevola plumieri* is dominant on the slope of the barrier dune at Sand Bank Bay, not *Coccoloba uvifera*.

A = Sand Bank Bay;

B = North Friar's Bay;

C = Mosquito Bay;

D = Half Moon Bay to Muddy Point.

Backdune

The backdune of North Friar's Bay is most often seen from the highway, where there is a weedy herbaceous sward, planted with *Terminalia catappa*, and defended by a mixture of *Acacia tortuosa* and *Hippomane mancinella*. From the seaside, and extending inland toward Friar's Bay Salt Pond, for 80% the total width of the backdune, *Coccoloba uvifera* is dominant. Then, toward the landward edge, the dune is broken into a collection of parts, with deep swales, and isolated islets of sand. Here are *Acacia tortuosa* (6-9 m tall), *Chamaesyce articulata* (few), *Clerodendron aculeatum*, *Cordia obliqua* (many), *Croton astroites*, *Lantana camara*, *Leucaena*

leucocephala (Lam.) de Wit, *Thespesia populnea* (large but few), and, at the far eastern end, a large population, with local dominance on the backdune, of *Corchorus hirsutus*.

Other Species and Ruderal Sites

In a dry gully, running through the backdune to the beach, are patches of *Chamaesyce mesembrianthemifolia* (low shrub), isolated plants of *Chamaesyce serpens* Kunth) Small, and patches of *Paspalum vaginatum*.

The Rocky Headlands at North Friar's Bay

Large black boulders, in seaside disarray, give to the Atlantic surf an anvil for its battering blows. Salt spray rises, on days of rough surf, 6 m into the air. The rocks, of volcanic andesite and rhyolite, despite the labor of the ocean, keep their sharp angles, and their coarse surfaces. *Sesuvium portulacastrum* alone grows draped from the tumble of rocks that face the full force of the sea spray. Higher on the rocks, where there is some protection from the full impact of the salt spray, *Lithophila muscoides* Sw. grows cupped in tiny hollows, one plant separated from another by the discontinuity in suitable surface for rooting. *Sesuvium portulacastrum* grows in the same sites as *Lithophila*, and then disappears as, moving over the crest of the headland farther inland, the vegetation - now composed of dense low stands of *Conocarpus erectus* with *Coccocloba uvifera* and *Wedelia calycina* - becomes wind-appressed scrub woodland. In the more open spaces near, but not as far toward the sea as *Lithophila*, two species of cacti were found, each represented by a single plant: *Melocactus intortus* and *Opuntia dillenii* (Ker Gawler) Haw.

The headland at the western end differs in a few respects. The first species to appear at a height above the beach (6-9 m), is *Chamaesyce mesembrianthemifolia*, growing in small amounts of soil trapped in cracks of bare volcanic rock (Howard 1989a). *Chamaesyce* is plentiful in this site. With it are *Lithophila muscoides* and *Portulaca quadrifida* L. Further back occurs *Sporobolus virginicus*, then *Coccocloba uvifera*, but never as densely as on the eastern headland. There is no *Conocarpus erectus* on this headland. A short distance further up the slope of the hill, which is the seaward slope of Sir Timothy Hill, are *Melocactus intortus* and *Pilosocereus royeni*.

Along the sides of the road to North Friar's Bay, and over the rocks of its embankment, are *Heliotropium curassavicum*, *Jacquemontia pentantha* (Jacq.) Don, *Portulaca oleracea*, and *Trianthema portulacastrum*.

Rocky Headlands at South Friar's Bay

On South Friar's Bay beach, visitors from cruise ships come ashore in small motor launches, and some, who have read about the tropical fish that feed and cluster around the coral at the base of the rocky headland at the western end of the beach, swim there to see them.

Three sites of interest at the western extremity of the beach are: (1) rocky headland facing the beach; (2) isolated rock, 6 m high, on the beach; (3) a cove of shrubs, *Melochia tomentosa* (1.5-1.7 m tall), and *Sesbania sericea* (also tall); and one tree uncharacteristic of a barrier dune, a mature specimen of *Terminalia catappa*.

On the rocky headland, mostly bare of vegetation, species occur in small populations. In the following list, the number after the species' name indicates the number of plants of this kind found at the site: *Calotropis procera* (1), *Coccoloba uvifera* (1), *Hymenocallis* sp. (6), *Melocactus intortus* (3), *Tabebuia heterophylla* (4), several *Acacia tortuosa* and too-many-to-count *Stigmaphyllon diversifolium*, and grass; there is no *Conocarpus erectus*.

On the isolated dome of rock (an "erratic"), there are *Acacia tortuosa*, *Chloris inflata*, *Emilia fosbergii*, *Lantana camara*, *Melochia tomentosa*, *Opuntia* sp., *Portulaca quadrifida*, *Solanum* sp., and *Terminalia catappa* (a very young tree).

Foredune and Barrier Dune at South Friar's Bay

Canavalia rosea, *Ipomoea pes-caprae*, and *Sporobolus virginicus* occur abundantly in Zone 2 of the beach but only toward the western end. What differs more at South Friar's Bay is the character and composition of the barrier dune. Unlike North Friar's Bay, the barrier dune is not continuously vegetated by one species; nor is it steep. Instead, there is an alternation of species. For a length, *Acacia* dominates, then *Coccoloba*. Sub-dominants vary too; for instance, *Lantana camara* in places, *Croton astroites*, and *Hippomane mancinella* in others. Periodically, there are breaks and gaps in the dune hedge, which there never are in the hedge at North Friar's Bay; so it is the very adversity of the wind that fortifies the position that defends against it. Occasionally, where the barrier of *Coccoloba* has given way, *Agave caribaeicola* appears; and in the last third of the barrier dune, at the far eastern end of the shore, there are species from the backdune, and species from the vegetation of the dry scrub forest. There Mt. St. Michael rises behind the barrier dune, and provides greater protection from the prevailing (easterly) winds. Species here are: *Caesalpinia bonduc*, *Capparis flexuosa*, *Corchorus hirsutus*, *Croton astroites*, *Jatropha gossypifolia*, *Lantana camara*, *Panicum maximum*, *Tecoma stans*, *Urechites lutea*, and, just over the crest of the dune near its very end, *Bursera simaruba*.

RUDERAL SPECIES

Harper (1944) defined a weed, "A plant that grows spontaneously in a habitat that has been greatly modified by human action". "Ruderal" is often used for "weedy". More particularly, ruderal plants are said to grow in waste places. A weed, on the other hand, might grow in a cultivated field. The disturbed sites at Friar's Bay are the sandy plain, the edges of the roadways, the access road to the beach at North Friar's Bay, the flat area west of the salt pond on its northern edge (where road stones have been dumped), and the wide verge along the Dr. Kennedy A. Simmonds Highway.

In the following list, species that are ruderal at Friar's Bay are listed. If a species is not ruderal in its habitat at Friar's Bay, although it is known to be elsewhere, it is not listed. For instance, *Boerhavia coccinea*, *Calotropis procera*, *Rivina humilis*, and *Vernonia cinerea* fit this category, excluded from the list because they occur only with the weakest representation. Ruderal species must be abundant, as well as occur on disturbed ground. Ruderal species at Friar's Bay are *Acacia tortuosa*, *Chloris inflata*, *Digitaria insularis*, *Heliotropium curassavicum*, *Jatropha gossypifolia*, *Passiflora foetida* var. *hispida*, *Portulaca oleracea*, *Rhynchoselytrum repens*, *Sesuvium portulacastrum*, *Spermatoce bahamensis*, *Stachytarpheta jamaicensis*, and *Trianthema portulacastrum*.

CHECKLIST OF THE FLORA OF FRIAR'S BAY

The following is a checklist of the flowering plants collected at Friar's Bay. Of the 127 species ("species" here used broadly to include infra-specific taxa as well) are nineteen monocots, represented by seven families, and 108 dicots, represented by 42 families. Of monocot families, five are represented by one species; grasses by thirteen species. Species not native (8) are indicated by '(naturalized')'. Families with the greatest number of species, are Fabaceae (13) and Poaceae (12). Euphorbiaceae (9) and Boraginaceae (8) are similarly species-rich in this flora. Some species of the flora of St. Kitts have in this study been documented by a voucher for the first time. *Aloe vera*, *Cocos nucifera*, *Melocactus intortus*, and *Pilosocereus royeni* were observed, and photographed, but not collected. Habit, abundance, and habitat are the categories in which information is given for each entry.

Acanthaceae

Ruellia tuberosa L.

herb, occasional, roadway muds, near salt pond

Agavaceae

Agave caribaeicola Trel.

herb (giant, acaulescent succulent), abundant, dry hillsides

Aizoaceae

Sesuvium portulacastrum (L.) L.

herb (succulent), common, seaside, sandy shores, and rocky headland
herb (succulent), common, seaside ruderal

Trianthema portulacastrum L.

Amaranthaceae

Achyranthes aspera L. var. *aspera*

herb (weedy), uncommon, shady dry woods
herb (prostrate), restricted habitat, rocky headland

Lithophila muscoides Sw.

Amaryllidaceae

Hymenocallis caribaea L.

herb, few, rocky headland, Caribbean side only

Anacardiaceae

<i>Comocladia dodonaea</i> (L.) Urban	shrub, few, shaded dry forest
Apocynaceae	
<i>Catharanthus roseus</i> (L.) Don.	herb (subwoody), abundant, sandy strand and backdune, (naturalized)
<i>Plumeria alba</i> L.	tree (small), some, dry rocky hillsides

Rauvolfia viridis Willd.

<i>Urechites lutea</i> (L.) Britton & Rose	shrub, dry pond side
	shrub (vinelike), common, sandy backdune

Asclepiadaceae

<i>Calotropis procera</i> (Aiton) W. Aiton	shrub (thick-stemmed), common, grassy roadsides
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Asteraceae

<i>Emilia fosbergii</i> (Nicolson)	herb, some, ruderal
<i>Vernonia cinerea</i> (L.) Less.	herb (weedy), common, roadsides
<i>Wedelia calycina</i> Rich.	shrub, abundant, dry rocky hillsides (scrub)

Avicenniaceae

<i>Avicennia germinans</i> (L.) L.	tree, to 16 m, common, salt pond edge
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Bataceae

<i>Batis maritima</i> L.	shrub (succulent), frequent, flat open salty muds
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Bignoniaceae

<i>Tabebuia heterophylla</i> (DC.) Britton	tree (small), some, mountain roadsides and scrub woods
<i>Tecoma stans</i> (L.) Juss.	shrub, abundant, grassy hillslopes, Caribbean-side

Boraginaceae

<i>Argusia gnaphalodes</i> (L.) Heine	shrub, some, barrier dune, Atlantic-side
<i>Bourreria succulenta</i> Jacq.	shrub or small tree, occasional, hillside
<i>Cordia globosa</i> (Jacq.) Knuth	shrub, some, pond edge
<i>Cordia obliqua</i> Willd.	shrub (arborescent), frequent, pond edge; shaded dry forest ghut, (naturalized)
<i>Heliotropium angiospermum</i> Murray	herb (sometimes woody), some, pond edge
<i>Heliotropium curassavicum</i> L.	herb (succulent), plentiful, pond edge, ruderal
<i>Heliotropium ternatum</i> Vahl	shrub, common, in scrub woods and windswept slopes
<i>Tournefortia volubilis</i> L.	shrub (vinelike), uncommon, pond edge

Burseraceae

<i>Bursera simaruba</i> (L.) Sarg.	tree, plentiful, dry forest sites and protected places back of barrier dunes
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Cactaceae

Melocactus intortus (Miller) Urban
Opuntia dillenii (Ker Gawler) Haw.
Pilosocereus royenii (L.) Byles &
 G. Rowley

succulent, abundant, driest hillsides
 succulent, rocky headland, rare
 succulent, common, driest hillsides and
 seaward slopes

Capparaceae

Capparis cynophallophora L.

Capparis flexuosa (L.) L.

tree (small), common, dry forest sites, pond
 edge on its eastern side
 shrub (small tree), often vinelike, common,
 pond edge and upland slopes

Celastraceae

Cassine xylocarpa Vent.
Crossopetalum rhacoma Crantz

Gyminda latifolia (Sw.) Urban

tree (small), rare, back of barrier dune
 shrub (large), one only, back of dune (South
 Friar's Bay)
 shrub (small tree too), some, dry forest sites

Combretaceae

Conocarpus erectus L.

Laguncularia racemosa (L.) Gaertn.
Terminalia catappa L.

shrub (and tree), sometimes prostrate, pond
 edge and rocky headland
 tree, plentiful, pond edge
 tree, few, strand, Caribbean-side,
 (naturalized)

Commelinaceae

Commelina diffusa Burm.

herb, few, mud of pond edge (not salty) and
 dry sites with cactus; shaded dry forest
 ghut

Convolvulaceae

Ipomoea pes-caprae (L.) R. Br.

Ipomoea triloba L.

Jacquemontia cumanensis
 (Kunth) Kuntze

Jacquemontia pentantha (Jacq.) Don
Jacquemontia solanifolia (L.)
 H. Hallier

herb (prostrate), abundant, sandy
 shores

herb, common
 vine (woody), uncommon

herb (weedy), plentiful, dry open verges
 herb (vine), some

Cucurbitaceae

Mormordica charantia L.

herb (climbing), dense patch, west side of
 pond

Cyperaceae

Fimbristylis ovata (Burm. f.) Kern

herb, rare, dry site with cacti and *Agave*

Erythroxylaceae

Erythroxylum brevipes DC.
Erythroxylum havanense Jacq.

shrub, common, dry scrub wood
 shrub (or small tree), common, dry hillsides

Euphorbiaceae

<i>Chamaesyce articulata</i> (Aubl.) Britton	tree (small), plentiful, dry forest
<i>Chamaesyce hirta</i> (L.) Millsp.	herb (weedy), common, roadway (from cracks in concrete)
<i>Chamaesyce mesembrianthemifolia</i> (Jacq.) Dugand	shrub (low), some, near barrier dune, Atlantic-side
<i>Chamaesyce serpens</i> (Kunth) Small	herb (prostrate), some
<i>Croton astroites</i> Dryander	shrub, abundant, scrub woods and dry forests
<i>Gymnanthes lucida</i> Sw.	tree (small), rare, dry forest ghut
<i>Hippomane mancinella</i> L.	tree, common, littoral wood and pond edges
<i>Jatropha gossypifolia</i> L.	shrub, common, weedy verges
<i>Pedilanthus tithymaloides</i> (L.) Poit.	shrub, common, scrub and shaded dry woods

Fabaceae

<i>Acacia tortuosa</i> (L.) Willd.	tree (small), common, edges of roads and woods
<i>Caesalpinia bonduc</i> (L.) Roxb.	shrub (scrambling vine), plentiful, dry sandy plain
<i>Canavalia rosea</i> (Sw.) DC.	vine, abundant, beaches and dry sands inland
<i>Chamaecrista glandulosa</i> var. <i>swartzii</i> (Wikström) Irwin & Barneby	shrub, abundant, rocky dry hillside and scrub woodland
<i>Chamaecrista obcordata</i> (Wikström) Britton	shrub, rare, scrub woodland
<i>Crotalaria retusa</i> L.	herb, grassy roadside, (naturalized)
<i>Galactia dubia</i> DC.	vine (woody), abundant, dry rocky hillside and scrub woodland
<i>Indigofera tinctoria</i> L.	shrub (weedy), common, roadsides and dry edges
<i>Leucaena leucocephala</i> (Lam.) de Wit	shrub, abundant, dry edges and roadside
<i>Piscidia carthagenensis</i> Jacq.	tree, frequent, dry forest
<i>Sesbania sericea</i> (Willd.) Link	shrub (annual), common, dry sandy sites
<i>Stylosanthes hamata</i> (L.) Taubert	herb, common, roadside ruderal
<i>Tephrosia cinerea</i> (L.) Pers.	herb, common, roadside ruderal

Goodeniaceae

<i>Scaevola plumieri</i> (L.) Vahl	succulent (shrubby), some, barrier dune
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Krameriaceae

<i>Krameria ixine</i> L.	shrub (low), abundant, very dry rocky hill
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Lauraceae

<i>Cassytha filiformis</i> L.	vine (parasitic), herbaceous, locally plentiful, backdune woodland
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Liliaceae

<i>Aloe vera</i> (L.) Burm.	herb, acaulescent, few, grassy upland, roadside, (naturalized)
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Malpighiaceae

Stigmaphyllo adenodon Adr. Juss.
Stigmaphyllo diversifolium
 (Kunth) Adr. Juss.
Stigmaphyllo emarginatum
 (Cav.) Adv.

liana (woody), common, scrub woodland
 liana, common (dominant groundcover in
 many sites), scrub woodland
 liana, some, scrub woodland

Malvaceae

Abutilon umbellatum (L.) Sweet
Sidastrum multiflorum (Jacq.) Fryx.
Thespesia populnea (L.) Sol.

subshrub, common, roadside ruderal
 subshrub, common, roadside ruderal
 tree, some, scrub woods and dry forest sites

Meliaceae

Azadirachta indica (L.) Juss.

tree, local stand, sandy plain, (naturalized)

Myrtaceae

Eugenia ligustrina (Sw.) Willd.

shrub (to small tree), plentiful, dry forest
 and scrub woodland

Nyctaginaceae

Boerhavia coccinea Miller.
Pisonia aculeata L.

herb (weedy), uncommon, dry sandy plain
 vine, rare, dry forest ghat

Palmae

Cocos nucifera L.

tree, some, Caribbean shore,
 (naturalized)

Passifloraceae

Passiflora foetida var. *hispida*
 (Triana & Planchon) Killip

vine (herbaceous), common, roadside

Phytolaccaceae

Rivina humilis L.

herbaceous or fruticose weed, some, shady
 dry wood

Poaceae

Aristida sp.
Bothriochloa pertusa (L.) Camus
Cenchrus incertus M.A. Curtis
Chloris inflata Link
Digitaria insularis (L.) Mez ex Ekman
Heteropogon contortus (L.) Beauv.
 ex Roem. & Schult.
Panicum maximum Jacq.
Pappophorum pappiferum
 (Lam.) Kuntze
Rhynchoselytrum repens (Willd.)
 C.E. Hubb.
Setaria setosa (Sw.) Beauv.
Sporobolus pyramidatus
 (Lam.) Hitchc.
Sporobolus virginicus (L.) Kunth

herb, some, dry open rocky hillside
 herb, some, disturbed dry rocky site
 herb, common, beach sands
 herb, abundant, waysides (ruderal)
 herb, common, waysides (ruderal)
 herb, some, dry rocky ground with cacti

herb, abundant, verges and edges
 herb, uncommon, roadside

herb, common, sandy plain & roadsides,
 (naturalized)
 herb, some, sandy plain
 herb, few, moist sands and edge of pond
 herb, abundant, colonist on beaches

Polygonaceae

Coccoloba diversifolia Jacq.
Coccoloba microstachya Willd.
Coccoloba swartzii Meissner in DC.
Coccoloba uvifera (L.) L.

shrub (small tree), few, windswept scrub
 shrub, few, with cacti on rocky dry hillside
 tree (and shrub in some sites), some, scrub
 tree or shrub (small), plentiful, barrier dune
 and beyond, especially Atlantic-side

Portulacaceae

Portulaca oleracea L.
Portulaca quadrifida L.
Talinum fruticosum (L.) A.L. Juss.

herb (succulent), plentiful, seaside ruderal
 sites
 herb (succulent), uncommon, seaside rocks,
 Caribbean-side
 herb, some, moist sands on edge of pond

Rhizophoraceae

Rhizophora mangle L.

tree (to small tree or shrub), abundant, the
 salt pond

Rubiaceae

Erihalis fruticosa L.
Randia aculeata L.
Spermacoce bahamensis
 (Britton) Howard
Spermacoce verticillata L.

shrub, plentiful, windswept scrub hillslopes
 shrub (small tree), some, scrub and dry
 forests
 shrub, cushion-forming, low, abundant,
 scrub hillslopes
 suffrutescent herb, uncommon, Mt. St.
 Michael

Scrophulariaceae

Capraria biflora L.

herb (woody), (weedy), abundant, sandy
 plain

Solanaceae

Physalis philadelphica Lam.
Solanum bahamense L.

herb, some, sandy plain
 shrub, abundant, pond edges and sandy
 plain, and lower margin of eastern
 upland

Sterculiaceae

Melochia tomentosa L.

shrub, common, sandy plain and dry open
 sites

Theophrastaceae

Jacquinia armillaris Jacq.

tree, common, scrub and dry forest sites,
 and one on bank of pond, east side

Tiliaceae

Corchorus aestuans L.
Corchorus hirsutus L.
Corchorus siliquosus L.

herb, some
 shrub, common
 shrub, some

Ulmaceae

Celtis iguanaea (Jacq.) Sarg.

vine (woody) or shrub

Verbenaceae

Citharexylum spinosum L.*Clerodendron aculeatum*
(L.) Schlecht.*Lantana camara* L.shrub, few, dry forest and scrub wood
shrub, abundant, dry pond edge, and edges
in *Acacia* grasslandshrub, abundant, sandy plain and dry edge
of pond on eastern side, and barrier and
backdune*Lantana involucrata* L.*Stachytarpheta jamaicensis* (L.) Vahl

shrub, some, sandy plain

herb, disturbed ground by road and pond

APPENDIX

When a validating herbarium specimen has been examined, "this is recorded with an exclamation mark (!) following the name of the island. Island records obtained from floras or descriptive work which are not verified with actual specimens are cited without the exclamation mark" (Howard 1978). The following species collected for this paper have been recorded in Howard without an exclamation mark: *Comocladia dodonaeia*, *Conocarpus erectus*, *Sidastrum multiflorum*, and *Sporobolus virginicus*. Other species collected for this paper have not been previously documented with a voucher from St. Kitts, and these are: *Abutilon umbellatum*, *Achyranthes aspera* var. *aspera*, *Argusia gnaphalodes*, *Bothriochloa pertusa*, *Capparis cynophallophora*, *Cassytha filiformis*, *Chamaecrista obcordata*, *Chamaesyce mesembrianthemifolia*, *Chamaesyce serpens*, *Coccocloba diversifolia*, *Corchorus hirsutus*, *Eriothalis fruticosa*, *Fimbristylis ovata*, *Gyminda latifolia*, *Jacquemontia cumanensis*, *Pappophorum pappiferum*, *Paspalum vaginatum*, *Physalis philadelphica*, *Plumeria alba*, *Sesbania sericea*, *Spermacoce bahamensis*, and *Terminalia catappa*.

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EPILOGUE

When the mosaic of habitats composing the immediate vicinity of Friar's Bay Salt Pond was first visited in the autumn of 1994, it was easy to see that building a hotel on the sandy plain between the sea and pond would alter the history of vegetation at the site. But it was not easy to imagine that we should in a short time witness the power of a force more destructive than man: the high winds of a hurricane.

The first hurricane of the 1995 season, Luis, rated 4 on the Saffir-Simpson scale, arrived at St. Kitts on the 5th of September. The last hurricane to strike St. Kitts was Hugo, in 1989. The high winds of Luis, first visible in the agitation of palm leaves, grew apace from 2 p.m., and quickened to strong gusts later in the day. The peak velocity of the hurricane winds were estimated to be 140 m.p.h., but there is no evidence at the time of writing for the obvious variation in velocity from hour to hour and place to place.

The capacity of island plants to endure and survive hurricane-force winds, and the accompanying salt-spray, varies from species to species, but on inspecting various habitats around Friar's Bay Salt Pond, it is clear that surviving the storm best were three kinds of plants: (1) mangroves; (2) semi-succulents of rocky headlands; and (3) the principal species of the Atlantic-facing barrier dune, mainly *Coccoloba uvifera*.

Inventory of the Storm's Effects

North Friar's Bay

There was much sea-blown detritus above the highwater mark (nylon rope, colored and clear bottles, planks, plastic pails, light bulbs, batteries, cigarette lighters, plastic cutlery, wood, sandals and shoes, and more), mixed with seawrack, but there

was no erosion of the sands, and in general the beach was unchanged. This was not at all true of the dune on South Friar's Bay.

On North Friar's Bay beach, *Coccoloba uvifera*, starting at the base of the barrier dune, holds the dune in place at all points in its elevation. There was little damage to this plant. A few leaves of plants mostly at the base of the dune were browned on their uppermost edges, and red brown roots exposed; otherwise, the green mantle of *Coccoloba* covering the wide high dune was unharmed. *Argusia gnaphalodes*, a minor associate of *Coccoloba*, had suffered some damage, visible as withered leaves, but about only 20% of the plant's photosynthetic surfaces seemed damaged.

One of the plants most exposed at all times of the year to salt-spray and seawind is *Lithophila muscoides*, rooted in cup-like depressions in the rocky headland at North Friar's Bay. In association with *Lithophila* is *Spermacoce bahamensis*. *Lithophila* and *Spermacoce* survived the hurricane without the least sign of diminished vitality, their glassy green succulent leaves were unharmed, and there were whole and secure blooms on each species. Further landward, *Sporobolus virginicus* which forms dense stands, and grows in the protection of the prostrate *Conocarpus erectus*, was discolored and dead-looking, or perhaps only shocked: time will tell. On the other hand, the entire stand of *Conocarpus*, dominating the headland in its middle zone, was unharmed. Further landward, *Acacia tortuosa*, as it was everywhere (on roadsides, on hills surrounding the salt pond, and on the sandy plain and its barrier dune), was browned, its leaves withered and dry, the color of red-brown earth. The two cactus plants on the headland, *Melocactus intortus* and *Opuntia dillenii*, were undamaged.

Salt Pond

Mangroves were intact. Lightly damaged were *Hippomane mancinella* and other woody plants of the pond margin, such as *Cordia obliqua*.

South Friar's Bay

From end to end, the vegetation of the dune, including *Acacia tortuosa*, *Agave caribaeicola*, *Coccoloba uvifera*, *Croton astroites*, and *Lantana camara*, has been uprooted and destroyed, the south side of the island having borne the brunt of the strong tailwinds following the passage of hurricane Luis northwest of St. Kitts. The soil and plant life of the Sandy Plain was now exposed to sea wind and salt spray. Gone too were the plants of the strand that edge out and range far from their first rooted positions: *Canavalia rosea*, *Ipomoea pes-caprae*, and *Sporobolus virginicus*. At the western end of the beach, the sea has cut beneath a few coconut palm trees (*Cocos nucifera*), trees which once formed a line parallel to the barrier dune. In the same area, leaves of *Thespesia populnea* were torn from their branches; those that were left are brown and withered. Species at the far eastern end of South Friar's Bay beach, *Capparis flexuosa*, *Jatropha gossypifolia*, *Tecoma stans*, and *Urechites lutea*, were uprooted and killed.

Sir Timothy Hill (Seaward)

Plants on both sides of the hill have been severely damaged. Once green, the woodland was now mostly brown, and open spaces were more common than the canopied cover of the days before hurricane Luis. On the west side of the hill, *Agave* was more visible, now that the leaves have been torn off *Bursera simaruba* (everywhere *Bursera* had lost its leaves, but rarely were its branches broken; perhaps not anywhere in the vicinity of the salt pond were its branches broken, or its trunk

uprooted), and seemed to be more abundant on that slope than earlier suspected. The tips of the leaves of *Agave* were more blackened and the leaves, near the ends and to a third their distal length, are scored by self-flagellation in the merciless wind. Leaves of *Croton astroites* were withered but not browned. The top edges of the leaves of *Coccoloba microstachya* were brown and brittle. But leaves of *Erihalis fruticosa* have been torn away and those that remain have been blackened. The same vulnerability to high winds has been exhibited by *Thespesia populnea*, on the west side of the hill, as well as in protected places by the pond edge. *Krameria ixine*, the abundant ground-covering plant of the eastern slope, has been 'fired' and is black and withered. *Pilosocereus royeni*, abundant on the east side and along the crest trail, has been damaged, half or more of the columns taller than .45 m having been broken and knocked over. Younger stems were undamaged. *Melocactus intortus* suffered little damage; in fact, damaged specimens may have been in their state of decay prior to the storm, and not affected by it. Of the small trees, on the trail and west side, half or more have had some limbs cracked and broken. One large *Capparis cynophallophora* was entirely uprooted, and a large *Jacquinia armillaris* as well. But others withstood the siege. Of all survivors, *Stigmaphyllon diversifolium* seemed to be first in every category of hardiness.

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A NEW SPECIES OF *PSEUDOTAXUS* CHENG (TAXACEAE) FROM CHINA

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ABSTRACT

The genus *Pseudotaxus* was first described from eastern China in 1947 based on specimens deposited in the Nanjing Botanical Institute herbarium. It seems that very little herbarium material of this genus has been distributed to any herbaria outside of mainland China. In fact, this author could only find duplicate material of the type collection at the Harvard University Herbaria. An examination of material from western and southern China by this author while he was in China in 1994 has revealed a new species totally different in leaf morphology from the eastern populations.

KEY WORDS: Taxaceae, *Pseudotaxus*, China, systematics

The type species of this genus, *Pseudotaxus chienii* (Cheng) Cheng was described from a few specimens collected from Chekiang (Zhejiang) near Lungtsuan. In the Chekiang specimens the leaves are distinctly linear, oblong, and in fact look similar to a typical *Taxus* L. species. In sharp contrast, the leaf shape of all other specimens of *Pseudotaxus* native in regions of China other than Chekiang have a distinctly oval leaf, also the leaf width is very broad, and in fact the western populations seem to resemble *Podocarpus brassii* Pilg. (Podocarpaceae) in general leaf form.

In the literature (Cheng & Fu 1978), have reported the genus *Pseudotaxus* as occurring naturally in Chekiang, Jiangxi, Hunan, Kwangtung, and Kwangsi to 1000 m elevation. Other reports, such as a local listing by a commercial seed company in Sichuan, Sichuan Seed Company in southwest Sichuan suggest it may also be native in southern Sichuan. A recent study of the embryology of *Pseudotaxus* from three separate populations done by Cheng & Wang (1978) included comparisons of material from Chekiang (Lungchuan County), Kiangsi (Ching-kiang Mountains), and Kwangsi (Sze-ming Mountains).

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Figure 1. Type specimen of *Taxus chienii* (GH).



Figure 2. Specimen of *Taxus chienii* (GH).

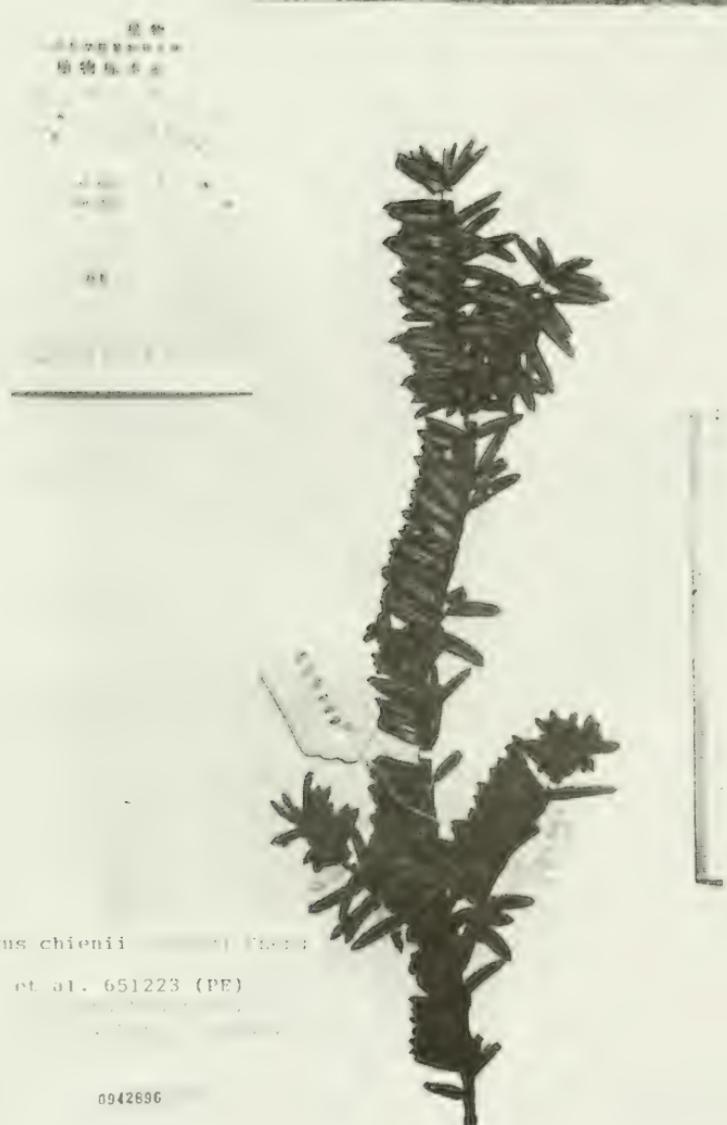


Figure 3. Specimen of *Pseudotaxus liiana* (PE).



Figure 4. Holotype of *Pseudotaxus liiana* (PE).

PSEUDOTAXUS LIIANA Silba, *species nova*. TYPE: CHINA. Guangxi: Lingui County, L.Q. Cheng 94669 (HOLOTYPE: PE).

Arbor ad 4 m alta; species affinis *Podocarpus brassii* Pilg. ab illa differt foliis ovata vel ovoideo-oblongis, foliis ad 2.8 cm longis et 4.0-4.5 mm latis, scorteus, apice acuminatis. Seminibus 4 mm latis, ovoideis, bene distinguitur.

This species is distinguished by its broadly oval or ovate-oblong leaves, 1.3-2.8 mm long and mostly 3.5-4.5 mm wide, the leaves somewhat warty on the upper surface like *Prumnopitys harmsiana* (Podocarpaceae) from Venezuela. The leaves are very thick and leathery like *Torreya* sp. (Taxaceae) with a distinct recurved margin, the leaf apex being abruptly narrowed to a short acuminate spine. The seeds are ovoid and at least 4 mm in diameter with the receptacle (dried) on the herbarium sheet.

This species is named in honor of Dr. Nan Li, former Doctoral student of Dr. L.K. Fu (PE) and now at Fairy Lake Botanical Garden in Shenzhen. It was the author's pleasure to meet Mrs. Li in Beijing in August of 1994.

Pseudotaxus liiana occurs in south and western China, and does not occur in Chekiang. This species does not appear to be in cultivation outside of mainland China.

In contrast, *Pseudotaxus chienii* with its linear leaves which are non-leathery, occurs only in Chekiang. It is cultivated at the Nanjing Botanical Garden and at the Arnold Arboretum in the U.S.A. The leaves of *P. chienii* are very narrow, usually 1.5-2.0 mm wide.

Specimens examined: CHINA. Guangxi: Lingui County, April 1953, L.Q. Cheng 94669 (type) [leaves short and very broad, 12.5-16.0 mm long by 4 mm wide]. Hunan: *sine loc.*, 625 m, *Chinese coll.* 352 (PE) [sterile collection]; *sine loc.*, *Chinese coll.* 159 (PE) [leaves *Torreya*-like, leaves at least 3 mm broad, margin recurved, leaf apex acuminate with a spine]; *sine loc.*, 1040 m, *Chinese coll.* 432 (PE) [sterile, leaf margin distinctly recurved]. Jiangxi: Lushan Botanical Garden, Lushan, cultivated, *Shanghai Bot. Gard. Staff s.n.* (SG); Jing Gang Mountain, October 1965, Ning Ying, et al. 651233 (PE) [leaves somewhat warty on upper surface like *Prumnopitys harmsiana* of Venezuela]. Kiangsi: *sine loc.*, 1965, *Chinese coll.* 651223 (PE) [sterile, leaves 3-4 mm wide or more, leathery, *Torreya*-like]; *sine loc.*, 850 m altitude, *Chinese coll.* 2668 (PE) [a plant 4 m tall, 8 cm d.b.h., sterile].

PSEUDOTAXUS CHIENII (Cheng) Cheng

In the type description, Cheng (1934) describes the species from Chekiang as being a shrub 2-4 m tall, with linear leaves 15-25 mm long, petioles 1-2 mm long, and broadly ovoid seeds.

Geographically, the flora of Chekiang (Zhejiang) seems to be very different from the flora of western China. Other gymnosperm genera that have separate species in Chekiang that are distinct from species in western China include the genera *Torreya*, *Abies*, *Pseudotsuga*, and *Podocarpus*. Notably in *Torreya jackii*, which is a very

distinct species and is restricted to eastern China, with other *Torreya* species occurring in western China.

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